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SCHOOL SCIENCE AND MATHEMATICS

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School Science and Mathematics

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Education is not a luxury; it's a necessity.—HENRY FORD

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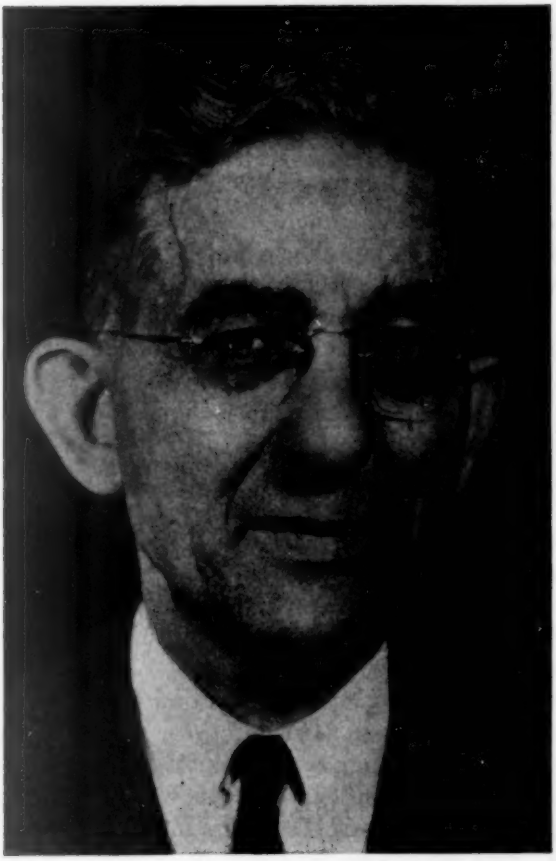


WILLIAM F. ROECKER
1880–1942

WILLIAM F. ROECKER

On Sunday, September 13, 1942, death called Mr. William F. Roecker, Treasurer of the Central Association of Science and Mathematics Teachers, and the Business Manager of SCHOOL SCIENCE AND MATHEMATICS. Mr. Roecker was recovering from an operation in St. Joseph's Hospital, Milwaukee, when he died suddenly and entirely unexpectedly.

Mr. Roecker was born in Dodge County, Wisconsin, sixty-two years ago. He was graduated from the West Bend, Wisconsin, High School and attended the old State Normal School in Milwaukee. After receiving his bachelor's and master's degrees from the University of Wisconsin, Mr. Roecker taught in the high schools of Durand, Spencer, Sheboygan, Plymouth and Sturgeon Bay, all in Wisconsin. He was then placed in charge of the science department of the University High School in Madison. In 1916 Mr. Roecker was selected as head of the Science Department of the Boys' Technical High School in Milwaukee, the position he held at the time of his death. Here he organized the work in science and brought it to its present high standard.

Principal Thomas G. Brown of the Boys' Technical High School said, "Mr. Roecker was more than a teacher in Boys' Tech. He often was consulted about various activities of the school. His supervision of the Science Department and the Cafeteria was of a high order." True, Mr. Roecker was more than a teacher at Boys' Technical High School. He organized the All-Science Section of the Wisconsin Teachers Association and served as its first chairman, and also helped to organize the Milwaukee All-Science Teachers Club. He was Secretary and Treasurer of the Milwaukee Schoolmasters Club as well as being the moving spirit in the Milwaukee Physics Teachers Club. He was on the finance committee of the City Club of Milwaukee. He held memberships in the National Association for Research in Science Teaching, American Association for the Advancement of Science, and the National Education Association.

Mr. Roecker was President of the Central Association of Science and Mathematics Teachers in 1928, and has been Treasurer, and Business Manager of SCHOOL SCIENCE AND MATHEMATICS since the publication was acquired by the Association. He served as chairman of some of the various sections of the Association and took an active part in its program.

Mr. Roecker contributed several articles dealing with the methods and problems of science teaching which were published in SCHOOL SCIENCE AND MATHEMATICS, all of which indicated that he possessed a keen sense of the problems that confront the classroom teacher of science.

Mr. Roecker was a familar figure at every meeting of the Association for many years, and hundreds of members valued his friendship and counsel. He was ever willing to give support to whatever project the Association undertook. His many friends always found him untiring in his efforts to help others, and so another worthwhile life has been spent, leaving memories which will be long cherished by his many pupils, co-workers and friends.

HIGHLIGHTS OF 1942 CONVENTION

For the benefit of the members of the Association and their guests who are planning to attend the 1942 Convention, the Executive Committee has issued the following advanced information. The complete information is furnished in the Yearbook, which has been sent to the members.

Date of the Convention:

The annual convention of the Association will be held this year on November 27 and 28. Friday, November 27: 9–12 General Session; 12:30–2:30, Annual Luncheon; 3:00–5:30, Sectional Meetings. Saturday, November 28: 8–10, Business Meeting and General Session; 10–12:30, Group Meetings.

Convention Headquarters:

Hotel Morrison has been selected by the Executive Committee as the convention headquarters. The hotel has previously served the Association in this capacity. Rates are reasonable and accommodations are adequate to meet every need of the guests. It is advisable to make reservations in advance.

Speakers at the General Sessions:

Hart, William L., Professor of Mathematics, University of Minnesota.
Hopkins, B. Smith, Professor emeritus of Inorganic Chemistry, University of Illinois.
Sears, Paul B., Professor of Botany, Oberlin College.
Tyler, Ralph W., Professor and Chairman of the Department of Education, University of Chicago.

Annual Luncheon:

Breslich, E. R., Professor emeritus of the Teaching of Mathematics, University of Chicago.
Carlson, Anton J., Professor emeritus of Physiology, University of Chicago.

By the action of the Board of Directors the Annual Luncheon on Friday

at 12:30 is to replace the Annual Dinner. The price of $1.40 includes tax and tip. Reservations may be made by writing Miss Cora Anderson and Miss Marie O'Keefe, DuSable High School, Chicago.

Section Meetings:

The chairmen of the various sections have completed their programs. The programs are centered about the theme of the Convention, namely, Correcting Educational Weaknesses for Future Strength. The following sections meet on Friday afternoon from 3:00–5:30: Biology, Chemistry, Elementary Mathematics, Elementary Science, Geography—Conservation, General Science, Mathematics, and Physics.

Group Meetings:

The group meetings are on Saturday morning from 10 to 12:30. The programs are centered about the applications of science and mathematics and the problems arising from their teaching. The following groups are scheduled to meet: Elementary School, Junior High School, Senior High School, Junior College.

Yearbook:

Complete information about the Association and the Convention is contained in the Yearbook. If you did not receive your copy, write to Prof. J. E. Potzger, Butler University, Indianapolis, Indiana.

DR. C. B. JOLLIFFE APPOINTED TO RCA MANUFACTURING CO.

Dr. Charles Byron Jolliffe, Assistant to the President of the Radio Corporation of America, and Chief Engineer of RCA Laboratories, has been appointed Vice President and Chief Engineer of RCA Manufacturing Company, Camden, N. J.

Dr. Jolliffe, born November 13, 1894, at Mannington, W. Va., was graduated from West Virginia University with a B.Sc. degree in 1915, and achieved the M.S. degree at West Virginia in 1920, and the honorary degree LL.D. from his Alma Mater in 1942. He was awarded the Ph.D. in 1922 at Cornell University where he was instructor of physics from 1920 to 1922. From 1922 to 1930 he served as a physicist in the radio section of the Bureau of Standards, and left that post in 1930 to accept the appointment of Chief Engineer of the Federal Radio Commission, the position he also held under the Federal Communications Commission in 1934.

Dr. Jolliffe resigned his FCC position in November 1935 to join the engineering staff of the Radio Corporation of America as Engineer in charge of the RCA Frequency Bureau. In 1941, he was appointed Chief Engineer of RCA Laboratories, and early in 1942 his appointment as Assistant to the President of RCA was announced. Dr. Jolliffe has attended many international radio conventions as a delegate of the United States and as a technical adviser. Presently he is serving on several Government wartime committees that pertain to radio communications and research. He is Vice-Chairman of Division C of the National Defense Research Committee of the Office of Scientific Research and Development; Secretary of the Industry Advisory Committee of the Defense Communications Board, and has served on other Committees of the Board. He is also a member of the Engineers Defense Board.

SOME ASPECTS OF SCIENCE TEACHING IN RELATION TO CIVILIAN DEFENSE

NATHAN A. NEAL
Supervisor of Radio Engineering Service, Assistant Supervisor Secondary School Science, Board of Education Cleveland, Ohio

Total war means total participation. Schools have a part to play. It is important that public schools promote understanding of the basic facts and principles related to the protection of American homes and communities in time of war. This cannot be achieved in an occasional assembly. Nor can it be achieved by leaving these fundamental things to chance coverage by the regular curriculum. War means changes and adaptations in the field of education. For in this war the enemy attacks us not merely on land, sea, and in the air, but also levels his attack at our heads and hearts, taking advantage of every prejudice, of every weakness. The Honorable John W. Studebaker, United States Commissioner of Education, has recently been quoted as follows:

> The schools hold an important sector on this battle line. They must use every device known to the profession to develop mental and spiritual preparedness—in a word, morale based on understanding. We must maintain a steady flow of educated citizens for the task ahead. One of the many things that can be done toward this end is to relate the school program to the war situation. All the background subjects must be clearly identified with the foreground situations. Otherwise, young people will feel cloistered and dissatisfied with scholastic activities. They may be tempted to leave school prematurely because of its apparent remoteness from the world struggle. But this problem is not to be met by occasional patriotic pep talks. It calls for integrated study and discussion as well as activity programs which make students and teachers conscious of their part in the struggle.

Our thousands of high school pupils in Cleveland represent as many thousands of homes. The people in these homes may find it necessary to combat the effects of bombs, fire, injuries, gas attack, and panic when their entire community is without the aid of normal services. We believe that we are an intelligent and literate nation; yet we have reason to wonder if this is true when we observe the evidence of superstition and unfounded fear with which we are daily surrounded. Recall Orson Welles' famous broadcast of the "Men from Mars" and imagine what could happen in many urban areas which might be bombed or subjected to the insidious devices of fifth columnists. Science teachers along with others have both an opportunity and an

obligation to serve the nation by bringing about a more widespread appreciation and understanding of how the facts, principles, and method of science may be utilized in reducing danger to life and property and preventing panic in this war emergency. There should be no hysteria, of course, but there must be a realization of the potentialities, and preparation for all the phases of the disaster which may at any moment fall upon us. If we believe in the scientific method, then we will wish to direct our competence as science teachers toward helping people to obtain all the available facts which may be pertinent in solving their problems of civilian defense in wartime.

These problems will involve participation in, and cooperation with a variety of services. It is desirable that citizens understand the need for, duties of, and facts related to the work of drivers corps, messengers, rescue squads, auxiliary police, bomb squads, air raid wardens, auxiliary firemen, fire watchers, demolition and clearance crews, road repair crews, decontamination squads, emergency food and housing corps, the medical corps, nurses aides corps, and other wartime emergency services. We, as science teachers, will be aiding in the conduct of total war, and hastening the victory to the extent that we aid the civilian population in obtaining the scientific facts which will be of greatest usefulness in preventing loss of life, property damage, and the devastation which results from panic.

What are these scientific facts? To what activities are they related? What problems will these scientific facts help to solve successfully?

The United States Office of Civilian Defense in Washington, has published a large number of pamphlets and bulletins which outline the activities and problems involved, as well as supply the important facts which are necessary to carry on the activities and solve the problems. These materials are available from the offices of the Cuyahoga County Civilian Defense Council in Public Hall. Our County Council through its public relations division has prepared a Manual for House-holders. This valuable publication lists ten vitally important rules for the conduct of civilian defense, and deals in some detail with activities and problems such as: Home protection, first aid, street blackout, home blackout, home refuge rooms, gas proof refuge rooms, and how to cope with incendiary bombs. This manual should be a familiar item in every classroom, as well as every home.

Let us turn now to the more or less technical means of air

raid defense. What are the items of basic information which should be included in our classroom work? The facts are quite familiar to most of you, and I review them merely as an indication of how they are being used in the experimental teaching outline in the science curriculum center. This is an area in which we as science teachers may perhaps make our most important contribution in the present emergency. For purposes of discussion some of the important scientific aspects of air raid defense may be divided under the following three headings: (1) Protection against gas; (2) Fire service; and (3) Protection against explosives.

Protection Against Gas

Poisonous gases and smokes in air raids may be produced under different conditions, and by various means. Ordinary fires caused by weapons, explosive bombs or shells, incendiary bombs, flame projectors or sabotage, mainly produce smokes which contain carbon monoxide and nitrous fumes as principal toxic agents. Chemical fires occur, when chemicals stored or used in industries are at the sites of fires. A practically limitless number of toxic gases may be formed under such conditions. Chemical warfare includes the use of gas bombs dropped from airplanes, or the spraying of poisons from specially equipped aircraft. In warfare a "gas" is any chemical substance, whether solid, liquid, or vapor, that is used in combat to produce physiological incapacitating effects on the human body. War gases are generally liberated in the air as vapors or irritant smokes. They produce their harmful effect by direct chemical action upon the internal or external surfaces of the body with which they come in contact. From the standpoint of duration of effectiveness gases may be divided into two groups. Nonpersistent gases are generally volatile substances that quickly evaporate when released from the container. They diffuse readily into the air and usually do not remain in effective concentrations for more than ten minutes. Chlorine, phosgene, and arsenical smokes are examples of nonpersistent gases.

Persistent gases are usually liquids that evaporate slowly, giving off dangerous vapor which mixes with the surrounding air to form toxic concentrations. Being nonvolatile liquids, persistent gases remain in effective concentration in the open air for many hours and in cold weather may persist for days and even weeks. Lewisite and mustard gas are examples of persistent

types which may be effective for many hours. Contact with ground or objects contaminated with these gases will cause skin burns until decontamination has been effected. This is obviously subject matter which science teachers are trained and competent to handle. The civilian aspects of gas warfare include a considerable range of scientific facts and principles. The influence of weather, of wind, rain, and sunshine on the persistence of gases may be a major factor in determining their effectiveness. Freezing may delay, and thawing renew the effects of persistent types. Pupils and all citizens should know that the most dangerous conditions under which any gas may be used are mild, calm weather, with or without fog. Physiological effects are even more important. War gases may be briefly classified in terms of physiological effects under the following four headings: (1) Tear gases (lachrymators); (2) Lung irritant gases; (3) Vesicants (blistering gases); and (4) Respiratory irritant gases. All of these effects are in proportion to the amount of gas present and the length of time a person is exposed to it.

The detection of gases is another scientific aspect of the problem. Generally they are detected either visually, by their odor, or by means of chemical reactions. The chemistry laboratory provides the best available source of sample odors by which people may be trained to recognize the various gases. Decontamination is a vital problem in applied chemistry. The use and care of gas masks involves information from the field of chemistry. The possibility of gas attacks, and the scientific knowledge necessary on the part of the public to successfully combat such attacks are alone sufficient to justify our attention as science teachers to this aspect of civilian defense.

Fire Service

Fire service in the home and community is a second area in which science teaching may make important contributions. The common incendiary bomb weighs one kilogram or 2.2 pounds. It consists of a thick walled magnesium tube, filled with a mixture of powdered aluminum and iron oxide, called thermite. When this type of bomb strikes, the thermite is ignited and burns fiercely at a temperature of 3000 degrees Fahrenheit. The thermite burns for about a minute setting fire to the magnesium casing. The molten magnesium which is the principal danger, burns for ten to fifteen minutes, and will set fire to anything inflammable within several feet. People need to know that dur-

ing the first minute, while the priming composition is burning, the bomb reacts very violently; jets of flame are emitted from vent-holes, and pieces of molten magnesium may be thrown as far as fifty feet. The thermite composition provides its own oxygen and so cannot be extinguished by water or smothering, but the magnesium must get its oxygen from the air or surrounding materials in order to burn.

The one kilogram incendiary, falling from a height of a mile or more, will penetrate all normal types of roof construction on homes. Such bombs may penetrate a plaster ceiling below the roof, but are unlikely to penetrate the first floor below. If not immediately extinguished and this calls for fire fighting equipment on the second floors and in attics, the bomb may burn through a wooden floor and possibly through other surfaces, causing a succession of fires in the building. Since hundreds of fires could be ignited simultaneously by a concentrated attack by incendiary bombers, it is evident that all normal and emergency fire fighting equipment in the community would be entirely inadequate. The people must take their own protection into their own hands. In order to so protect themselves citizens need to understand the simple scientific facts about combustion, namely: That fire can occur only when three factors exist. These, as you know, are a combustible (or burnable) substance, the proper kindling temperature, and sufficient oxygen. Fire may be extinguished by removing any one of the three necessary factors. In order to act effectively people need to know why a fine spray must be used on incendiaries, while a stream of water is better for extinguishing ordinary burning materials. The United States Office of Civilian Defense has issued a forty-four page bulletin called *Fire Protection in Civilian Defense*. This booklet would be valuable today in every science classroom.

Protection Against Explosives

A third approach to better civilian defense through science teaching is offered by the problem of protection against explosives. Explosive bombs may produce three general effects which are described as destruction caused directly by the explosion, fire caused by the high temperature at which the explosion takes place, and the formation of toxic gases and smokes. Thus protection against explosive bombs is partly included in the two previous sections on protection against fire and toxic gases. Direct destruction by high explosives includes problems of

pressure, impact, fragmentation, properties of fragments, penetrating power of fragments, radius of danger, cratering, and others. The high explosive bomb is the most effective weapon for causing major damage to buildings, industries, and utilities in general. Hence, it is reasonable to assume that these bombs will be the weapon most frequently employed in air attacks against such objectives.

Three types of high explosives are fragmentation, demolition, and general purpose bombs. Of these the fragmentation type is the least serious, from the point of view of protection. They are of relatively small size and low power and are effective only against personnel in the open. Although they may cause widespread casualties among crowds in open places, most ordinary houses afford adequate protection against such bombs. Hence, the double importance of civilians remaining in their own homes whenever possible during attacks from the air. By so doing they are able to extinguish incendiary blazes before serious conflagrations get under way, and at the same time are better protected from fragmentation bombs than would be the case if they rushed into the open air.

The demolition type of high explosive bomb is very destructive to even the sturdiest of targets, but is localized in its action, and can attain its full effect only by a direct hit on a specific target. Only one or two such bombs can be carried by the average bomber, and their threat to the civilian population will be limited to areas immediately surrounding the vital military targets against which such bombs are normally employed.

The third, or general purpose type of high explosive bomb constitutes the most serious threat to the civil population. This type has a more widespread effect, and does not require a direct hit to do great damage. Many such bombs can be carried on one bomber, and they are relatively effective against a wide range of military, industrial, and public utility objectives.

Science teachers, as well as others can be of great assistance in helping the civilian population to understand and appreciate at the outset the fact that complete immunity from the danger of high explosives is impossible of attainment. The objective to be sought is, therefore, a balanced program of reasonable protection. Massively constructed large group shelters against high explosive bombs are not desirable for the total population, first because of the terrific loss of life which would result from a direct hit on such a structure, and second because of the neces-

sity for civilians to remain in their homes in order to be able to combat the effects of incendiaries which are almost certain to be a part of any extensive air attacks on the community. The point of view which contributes most to maintenance of morale is one which recognizes that a certain number of casualties will occur, but at the same time appreciates the fact that the chances for survival are very good for any given individual or family group.

A measure of protection for employees of banks, large stores, warehouses, and other places of business may be afforded by sub-basements, strongly built cellars, vaults, and other types of underground rooms, which would hold fast if the buildings above them were wrecked by bomb blast or shock. Even where the floor over a basement or cellar is incapable of supporting the load of debris that may fall on it when the building is partially or entirely wrecked above it, it can be strengthened by the use of additional columns or girders of steel or concrete. There are readily available specifications which indicate the extent to which floors over basement shelters need strengthening. The need for such reinforcement is determined by the type of construction and the total load which may have to be supported. The same factors apply to private dwellings in cases where the basement is to be used as a refuge for protection against bombs. If it becomes established that the flooring over a basement is strong enough to support the maximum expected load, then a refuge room below ground is preferable in private homes because it gives the best natural protection against blast and splinters. If above ground refuge rooms are to be used for protection against bombs then the guiding principle is to choose a room that is already protected as much as possible by surrounding walls of brick, stone, or frame construction, including the walls of the house next door.

Tables which give the proper procedures for strengthening the floors above basements, along with a large amount of additional scientific information related to civilian air raid defense are found in the 335 page book entitled *Civil Air Defense*, published in 1941 by the McGraw-Hill Book Company of New York. Another reference which is somewhat more technical in its presentation of the large amount of scientific material related to civilian protection is *Air Raid Defense*, 240 pages, published by The Chemical Publishing Company, of Brooklyn, New York.

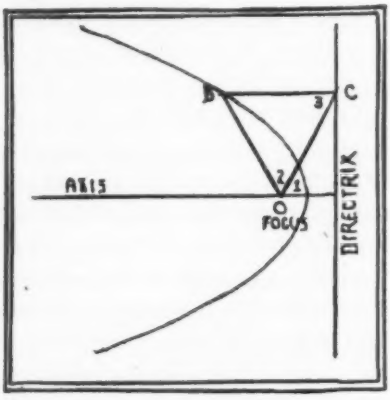
In this brief discussion of some aspects of science teaching in relation to civilian defense, I have attempted to emphasize

first, the necessity for public education, and high schools in particular, to have a part in solving the tremendous problems of civilian defense; and, second, the contribution which science teaching may make in the areas of protection against gas, fire service, and protection against explosives. There can be nothing lost by our making our maximum possible effort in this direction. There may be a great deal to gain.

METHOD OF CONSTRUCTION OF A PARABOLA

RICHARD BATEMAN
Dayton, Washington

This method is based on the property of the parabola, that any point on the curve is equidistant from the directrix and the focus. Thus in the figure, $CB = OB$ by a fundamental property of the parabola. Since $CB = OB$, $\angle 3 = \angle 2$. Also, since the distance from a point to a line is measured as the perpendicular from the point to the line, CB is perpendicular to the directrix.



Since the directrix is, by definition, perpendicular to the axis, CB is parallel to the axis, hence making $\angle 1 = \angle 3$ and therefore $\angle 1 = \angle 2$. This last equality is the basis of the method of construction.

Draw any line OC intersecting the directrix at C, and from the point of intersection construct CB perpendicular to the directrix. Construct $\angle 2 = \angle 1$. The point of intersection B lies on a parabolic curve. Performing this operation several times gives enough points to constitute a fairly accurate approximation to the curve.

NON-PRIORITY PHYSICS EQUIPMENT*

RICHARD C. HITCHCOCK
State Teachers College, Indiana, Pennsylvania

Teachers must have equipment to make physics practical and interesting, but schools and colleges have no priority at all for new equipment. What are you doing about it? What can you do about it?

Let's say that you are a teacher in Western Pennsylvania, and of course you know that KDKA was the first radio broadcasting station. Would you like to see a burned-out transmitting tube from KDKA? Did you ever see a 10,000 volt rectifier tube? What is the biggest air-cooled transmitter tube? What is the smallest receiving tube?

Are you interested? Are you curious? You can be satisfied, not by pictures nor by words, but only by the actual equipment. A picture is worth ten thousand words: seeing is believing. Let us take one step further: the handling of equipment of life-size, full weight, and natural color, is infinitely more satisfactory than any picture. To coin a phrase, "*handling is understanding.*"

A well chosen series of radio tubes, from the earliest to those now available, can be collected by anyone with sufficient persistence. Even big radio tubes (inoperative of course) can be secured if a little time, tact, and tires are used. The development of the radio tube, from a test-tube like affair having a short unreliable life, to the huge transmitter tubes having over a year of certain performance, is much clearer and effective when the actual devices are available for inspection and handling.

A tiny radio receiving tube may have an output of 0.10 watt, but the 10 KW transmitter tube handles 100,000 times as much output energy. Comparisons like this make the subject understandable and interesting, particularly if (1) the two tubes can be handled physically, and (2) if the 10 KW tube came from a well known local transmitter.

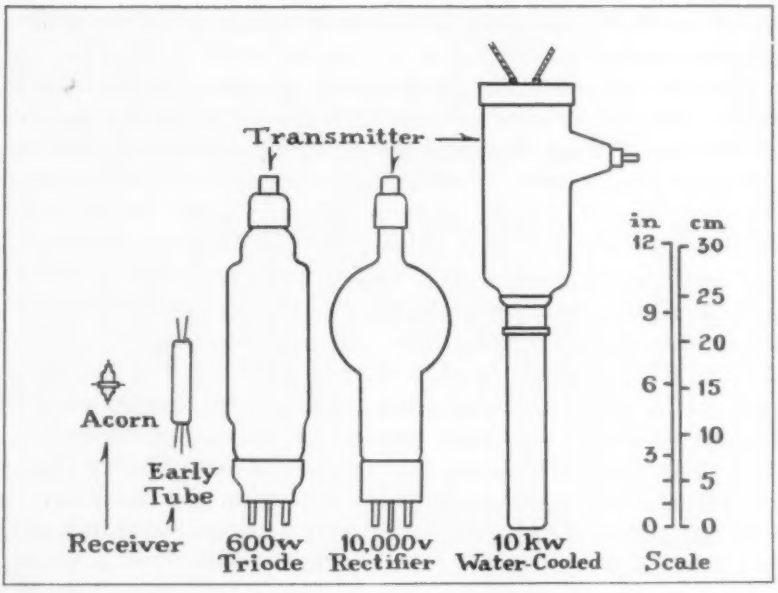
Let me make it clear that I am using KDKA as an illustration. I am not suggesting that you all write or call at this particular station for transmitter tubes. It wouldn't work.

The mere collection of any kind of junk is not recommended. But if you have a central idea—for example the portrayal of a series of radio tubes both in time development and in various

* Given May 9, 1942 at Westminster College, New Wilmington Pennsylvania, before the American Association of Physics Teachers of Western Pennsylvania.

sizes of transmitter and receiver types—the results will be a valuable adjunct to your Physics Museum.

To take another instance in which a junked piece of apparatus is of value, consider the automobile differential. Can you describe a differential gear so that someone who had never seen one could understand it? This is really difficult. The need and application is definite, cars must drive both rear wheels even when one travels further in rounding a turn. Now, why does only one wheel spin when the pavement is slippery? Maybe this ties right in with the action of the differential. But does it, and if so, how? Can you put it into words? Is a word description adequate?



SET OF RECEIVER AND TRANSMITTER RADIO TUBES

There is just one sure way that I know to have a student understand a differential: that is to get a differential. Perhaps its driving pinion has a defective tooth, and for this reason may be donated or purchased as scrap iron. Take off the outside cover so that all the gears and axles are visible. Give the student a few directions on turning the drive shaft and holding one or the other of the rear wheel axles. Though it is difficult to put into words, the student can work out and understand the action by the handling of the elements plus the examination of the complete

mechanism in slow operation. This is true physics laboratory procedure!

Your physics student rarely understands the peculiarity of the differential gear. This lies in the fact that the power is applied through the bearings on which the pinions rotate. Such an unusual method of mechanical working becomes clear when the actual differential gear is slowly worked by hand. And that is real understanding—not parrot knowledge or verbalism.

Parenthetically, the first differential I ever worked with was driven by a chain, and had only spur gears. If you completely understand the present-day bevel or hypoid differential, try to imagine first a Pierce-Arrow of 1900 vintage, and second to think how a satisfactory differential was made using nothing but spur gears. I should like very much to get an old spur gear differential, to show the stages of development up to the present bevel gear device. Since I know exactly what I want, some day I shall find it; there is a place waiting for it in our Physics Museum.

You may ask, "Just where can equipment be secured?" The correct answer is, "Just about anywhere." Commercial companies may be glad to send typical or experimental products for their advertising value. If this is done, it is only fair to tack a card on such a display, stating that the materials are "Courtesy of Blank & Co." A photograph of such a display showing the card, sent to the donor, may pave the way for future exhibits.

A second source of equipment is private individuals. More often than you might think, there is some one whom you know well, who is keeping some piece of equipment but not using it; keeping it because he "doesn't like to think of throwing it away." In just this manner a few weeks ago I ran across an 1895 telephone transmitter. This is undoubtedly a rarity, yet the owner was glad to give it to our museum, where it would be of value and benefit to many.

The third source, as has been intimated, is the junk yard. Big chunks of iron and brass are of no particular interest, but practically any part of any machine shows one or more principles of physics. Some criterion of selection must be used. One such idea is to select small pieces on the assumption that scrap metal prices depend on the weight of the object. Granted that big equipment is more easily seen by a large group—remember that small equipment can be passed around for first-hand tactual impressions, the real way to understand.

Finally, students react favorably to actual equipment whether in full working order or not. Have a specific idea, tell it to your friends and associates, and above all keep your eyes open for sources of supply. You will be surprised at how quickly you will have a collection of suitable items.

MATHEMATICS HELPS OUR AERIAL OFFENSE

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Faster and faster we wing the skies. Today the key word in war is speed. Consider two pursuit planes traveling toward each other at the rate of 350 miles per hour. Tick, tock! and the P-40's are about three city blocks closer to each other. The high speeds of modern warfare make it more dependent upon mathematics than ever before. Yesterday the command was "Fire when you see the whites of their eyes!" Now we fire at the enemy by means of observations and computations—even before we can see them.

Victory through air force superiority implies the use of several technical skills, of which mathematics is one. In the next few moments, I will mention some of the uses of mathematics in the designing of powerful planes, in the bombing of enemy objectives, and in the firing of anti-aircraft guns.

Swifter planes have been designed by aeronautical engineers through the study of streamlining. About five years ago, an airplane company in Southern California offered $12,000 for the mathematical solution of a certain differential equation dealing with streamlining. This inducement led to a solution that gave a much more effective airplane wing.

Often when a more sturdy, air-worthy ship is designed, it is because of some new discovery in the strength of materials, or to some new application of the principles of stress analysis. Both of these technical fields of engineering are highly mathematical in their nature.

. . . Listen! There goes a roaring B-26 to scout the enemy area. On the bomber a movie camera is mounted to take photographs of the area covered. The aerial photogrpah is to serve two purposes: It is used to detect enemy information, such as communication lines, harbors, war-craft factories and other military objectives. The photograph is also to be used to make maps

of the enemy-infested area, so that tactics against the foe can be planned. The principles of trigonometry are used to determine the scale of the aerial map. The addition of a north and south line and a military grid system of lines completes the map. Thus the homeward bound B-26 returns with data for a valuable military map of the enemy area.

The best defense is a good offense. By the use of a map of the enemy area and other pertinent military information, plans are carefully made for an air attack. The B-26 again roars in the skies.—Hours later, the sleek bomber sights its objective and discharges its deadly cargo. When the plane is directly over the target below, the bombs will hit their objective. This means that nearly four miles before the plane reaches the target, the bombs must be released. Just when they should be dropped is a complex problem that must be solved by considering the speed and altitude of the plane, the direction and velocity of the wind and other atmospheric conditions. This problem is solved by the skillful use of the automatic bomb sighter.

When we weaken our enemies by air raids, we must expect air attacks from them. Effective air defense is maintained by locating good anti-aircraft gun equipment in strategic spots. Successful firing of the anti-aircraft gun depends upon knowing the altitude of the enemy plane, the speed of the moving target, and both the direction and angle of elevation of the attacking plane. From these quantities are computed the data for aiming at the moving target, also the time setting for the fuse that will cause the shell to burst in the vicinity of the target. A data computer operated along with an automatic range finder solves the problem almost instantly. The gunner is also helped by firing charts, which take into consideration such quantities as wind velocity, muzzle velocity of the bullet, atmospheric density, humidity, barometric pressure, temperature at the gun, powder temperature, weight of the bullet, and drift caused by wind. The man at the gun is further aided by trajectory charts, which show the time setting of the fuse for various angles of elevation. The gunner fires the huge gun! An unfriendly bomber is crippled. He fires again. This time the raider is hit. A blazing mass streaks the skies. Seconds later, an enemy plane crashes to its doom!

Victory through air force—yes. Victory—through out-matching our enemies by our fast moving planes and our rapid firing guns. Victory through our skillfully trained men, both in our aircraft factories and on the battle field.

SCIENCE EDUCATION AT THE JUNIOR-HIGH-SCHOOL LEVEL, *CIRCA* 1776–1827

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Numerous contradictory statements in present-day histories of education, as well as in textbooks on science education, concerning the introduction of science into the school programs of studies, particularly at the junior-high-school level (grades 7–8–9), confuse the reader and inspire doubts of their authenticity. Those who are interested in becoming better acquainted with the origins and development of science education at the junior-high-school level are almost certain to be misled by the accounts at present available to students of educational history.

The present writer was once taught that "in the seventies and eighties came the sciences" into our secondary schools. Recent research covering the period 1776–1827 has shown that there was science education, at the junior-high-school level, in our American schools as early as the late eighteenth century. Science material was taught during the period 1776–1827 as an actual part of the school program in connection with (1) geography, (2) readers, (3) special science textbooks, and (4) lectures on nature. The material was offered in (1) common schools, (2) grammar schools, (3) academies, seminaries, and private monitorial schools, and at the end of the period, (4) high schools.

After a thorough study of available literature (contemporary periodicals; textbooks; federal, state, and city reports; programs of studies; etc.), the present writer has reached certain conclusions which might be of interest to junior-high-school teachers of science.

1. At the beginning of the period 1776–1827 educational opportunities for children of junior-high-school age were few; this is true whether we are considering the schools available or the quality of the teachers being employed. Schools were often taught by untrained and ignorant men and women. Educational opportunities gradually increased as the period progressed. Academies were established at many places. Educational systems were reorganized. Near the end of the period high schools existed in the larger towns. Teaching personnel improved in quality. The educational situation at the end of the period was much more favorable for instruction in science education than it was at the beginning of the period.

2. There developed a widespread interest in certain fields of science during the period 1776–1827. Science was being popularized through adult's and youth's literature, textbooks, lectures, and by founding scientific societies for the cultivation of the natural sciences. The beginnings of science instruction at the junior-high-school level may be found in the early writings designed for the use by and education of youth. Many of the books written for youth contained material covering the seasons, barometers, fire, water, and so on. Many of these writings emphasized first-hand study of scientific phenomena.

3. As early as the eighteenth century geography was offered at the junior-high-school level in American schools. By the end of the period 1776–1827 geography was taught in most of the common schools, grammar schools, high schools, academies, seminaries, and other types of private schools offering work at the junior-high-school level. It was offered in the Boston Latin School. By 1827 geography was a subject required by Massachusetts State Law to be taught in the common schools of that State. By the end of the period other sciences were being introduced into some of the schools at the junior-high-school level. They appeared in high schools, academies, seminaries, and other private schools. Some of the subjects taught were astronomy, natural history, natural philosophy, geology, mineralogy, botany, and even chemistry. By means of geography textbooks and readers the other sciences had been introduced into the common schools. In some instances teachers of common schools may have introduced the special sciences as subjects for the more advanced students, but this must have been seldom if at all.

4. Geography textbooks written for the junior-high-school level during the period 1776–1827 were encyclopaedic, meant to be memorized, and descriptive, rather than explanatory. The method of beginning with the whole and analyzing through to the smaller units, was employed by all authors until near the end of the period. More and more geography textbooks were published as the period progressed. They were never larger than 12-mos. Jedidiah Morse was the outstanding author of school textbooks in geography. Other prominent authors of geography textbooks were Morse's son Sidney Morse, Nathaniel Dwight, William C. Woodbridge, Joseph E. Worcester, and Joseph A. Cummings. There were many other geography textbook writers of the period. The science content found in the geography textbooks included chiefly material on astronomy,

physical geography, subterraneous geography, and biological topics. Water, air, soil, movements of celestial bodies, and eclipses, were common topics included. Electricity, heat, light, the harvest moon, and similar topics were explained. Topics from many different sciences were introduced into the early geography textbooks.

5. Early in the first decades of the nineteenth century school readers were being published that contained much science material. Topics from agriculture, botany, astronomy, chemistry, natural philosophy, natural history, zoology, physical geography, and other sciences, were introduced into the schools by the way of reading lessons. Experiments were described; scientific attitudes were developed. Other school textbooks published for pupils at the junior-high-school level attending schools and academies dealt with various fields of science. Natural philosophy textbooks appear to have gained the greatest favor with those who planned the school offerings. These textbooks contained material which would today be placed in physics textbooks, with the addition of many astronomical topics. Textbooks on astronomy were available near the end of the period. Chemistry textbooks were also being written, or copied and revised from English editions, for the schools and academies. They were written for use at the junior-high-school level and for more advanced pupils. Two of the most popular textbooks were revised editions of Mrs. Marcet's *Conversations on Natural Philosophy* and her *Conversations on Chemistry*, first published in England. Botany began to be a popular study for "young ladies" during the period, and, as might have been expected, botany textbooks began to appear which were designed to be used in schools and academies. No physiology or anatomy textbooks were discovered. There could be found in the didactic literature, the geography textbooks, the school readers, and in the special science textbooks, elements of science which are still considered valid in terms of present-day programs of junior-high-school science. Some material was found which would be omitted today. Beer and wine were sometimes called for in performing experiments. They were not regarded as evils against which the students should be warned.

6. A few of the instructors of the period 1776–1827 had available considerable apparatus to use in science instruction. The teachers of the common school were not so fortunate in this respect; the teachers of many private schools, however, were

well supplied with science apparatus. One of the best equipped schools was the Boston Monitorial School. Many academies, and some of the high schools, established in the early decades of the nineteenth century, provided for science apparatus. Where apparatus was available experimentation was carried on. One teacher used the crayon and blackboard, natural objects, and science apparatus in science instruction. Many teachers made their own equipment. Most of the instructors, in teaching science, used methods other than that of experimentation. Much of the science material was introduced by reading lessons—from geographies and school readers. Recitation of lessons committed to memory was popular in the early decades. As the period approached its end, many teachers began to ask questions of the pupil and require an answer—an answer usually memorized from the textbook. Some teachers required themes to be written; these themes often contained science material. Earlier in the period almost all students had been taught as individuals; later, the monitorial plan introduced group instruction. The techniques of group instruction tended to result in a descripion of, and reading about, the phenomena of science, rather than first-hand investigation as a way of learning. Some of the teachers—William Fowle and William Smith, as examples—taught very much as do many science teachers of today, by lecture and demonstration.

7. Attempts were made, in the period 1776–1827, to utilize science as a means of training in reflective thinking. The dominant purpose of science material introduced into the schools however, was the imparting of factual knowledge. The religious objective was strong. Some believed that contact with nature would help youth appreciate its beauties and wonders. An acquaintance with nature, with astronomy in particular, was expected to elevate and enlarge the pupils' views of "the wisdom and greatness of the Creator." The utilitarian value was sometimes mentioned.

8. The criticisms of early education, which affected instruction in science, were varied. The teachers were declared incompetent to teach science. There were no institutions to prepare men and women for teaching. The programs of studies were not varied enough. Science was not emphasized as it should be. Females, in particular, were not offered the educational opportunities they deserved. They were not offered certain materials in science which were being made available to males. In the

early years of the period it was claimed that the science books were written by the English for the English. In the later years, as Americans began to write, the textbooks were criticized because they were organized for memorization, and for deductive instruction instead of for inductive teaching. It was said that methods of instruction centered around memorization rather than around training in reflective thinking. It was claimed, truthfully, that textbooks in many of the special sciences, which were understandable by students of junior-high-school age, were not available. Few teachers, it was maintained, had sufficient science apparatus available to instruct students in many of the principles of the special sciences.

9. It was believed that some new plan for obtaining teachers should be devised. Training institutions for teachers should be established. Science should be taught to teachers and potential teachers in these training institutions. The programs of studies for the students at the junior-high-school level should be widened in scope; they should include more science. It was proposed that in two years the elements of instruction might be acquired; the remaining eight years should be used for instruction in the higher branches of knowledge, including the sciences. Females should be instructed on a higher level than the common and grammar schools were offering. Students should be divided into classes, with the individuals of each class on the same level. Textbooks, particularly geographies, should be written so as to begin with home material. Textbooks in the special sciences should be written for introduction into the schools. Students who were to learn science must work or perform operations in it. Increased use of apparatus in science teaching was proposed. Students should be taught familiarly, thoroughly; taught to *examine*, *inquire*, and *to think*. Demand of them not only *what* but *why* and *wherefore*. It was proposed that education should not consist only in the acquisition of knowledge but in the development of the mind.

Such is the picture of science education at the junior-high-school level during the period 1776–1827 as gained by the present writer through wide reading of its contemporary literature. Is that the picture which you have had of science education in American schools of over a century ago?

To escape criticism, say nothing, do nothing, be nothing.

THE GENERAL EQUATION OF THE CONIC

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1. The equation of second degree with real coefficients,

$$F(x, y) \equiv ax^2+2hxy+by^2+2gx+2fy+c=0, \tag{1.0}$$

with a and b not both zero, defines a conic. This equation has received detailed discussion at the hands of many writers, especially in the analytic geometry textbooks by Eisenhart [1],* Smith [2], and Woods [3]. The treatment is mainly concerned, however, with translation and rotation of axes to obtain a simplified form of the conic with center at the origin. In the works of Snyder and Sisam [4], and Dresden [5], dealing with analytic geometry of three-space, one finds rather complete methods for classifying quadrics by means of invariants and the discriminating cubic. It would be a relatively simple matter to specialize these latter methods to the conic. In this paper we shall arrive at the principal parts of the general conic by other methods.

2. The slope of the axes of (1.0) are given by

$$hm^2+(a-b)m-h=0, \qquad m=\tan\theta. \tag{2.0}$$

Also, (1.0) is the product of linear factors when

$$\Delta \equiv \begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = 0. \tag{2.1}$$

In what follows, we shall agree to take ϕ as that value of m determined by (2.0) which has the same sign as Δh. We shall also use the letters $A, B, C, \cdots$ to denote the cofactors of $a, b, c, \cdots$ in the determinant Δ, and

$$K = \sqrt{\Delta h/\phi}. \tag{2.2}$$

The points of intersection of a given line

$$x = x_0 + \lambda r, \qquad y = y_0 + \mu r \tag{2.3}$$

with the conic (1.0) are determined by substituting the latter values of x and y into (1.0) obtaining a quadratic in r

$$Qr^2 + 2Rr + S = 0, \tag{2.4}$$

Numbers in brackets refer to the Bibliography.

where

$$Q \equiv a\lambda^2 + b\mu^2 + 2h\lambda\mu,$$

$$R \equiv (ax_0 + hy_0 + g)\lambda + (hx_0 + by_0 + f)\mu, \tag{2.5}$$

$$S \equiv F(x_0, y_0).$$

The roots of (2.4), r_1 and r_2, are the distances from the point (x_0, y_0) on the line (2.3) to the points in which this line intersects the conic. If $R=0$ for all values of λ and μ, then the roots of (2.4) are equal in magnitude but opposite in sign, i.e., (x_0, y_0) is the mid-point of all the chords drawn to the conic (1.0). But this condition also takes the form

$$ax_0 + hy_0 + g = 0, \qquad hx_0 + by_0 + f = 0. \tag{2.6}$$

The solutions of (2.6) give the *coordinates of the center* of the conic (1.0),

$$x_0 = (hf - bg)/C = \frac{G}{C}, \qquad y_0 = (hg - af)/C = \frac{F}{C}. \tag{2.7}$$

When $C=0$, the conic has no center, i.e., it is a parabola or a pair of non-intersecting lines. If $C=0$ and $hf-bg=0$ also, then

$$\frac{a}{h} = \frac{h}{b} = \frac{g}{f} \tag{2.8}$$

and (2.6) is a pair of coincident lines. Since (2.8) is equivalent to the condition that $\Delta=0$, we see that (2.8) is sufficient for (1.0) to degenerate into the product of linear factors.

The *equation* (1.0) *referred to* (x_0, y_0) *as origin* becomes

$$F_1(x, y) \equiv ax^2+2hxy+by^2+S'=0. \tag{2.9}$$

Multiply the first and second equations of (2.6) by x_0 and y_0, respectively, and subtract the sum of these from $F_1(x_0, y_0)$ to obtain

$$S'=gx_0+fy_0+c. \tag{2.10}$$

By means of (2.7) and (2.10) we find, for $C\neq 0$,

$$S'=\Delta/C. \tag{2.11}$$

3. We shall now determine the foci, directrices, major and minor axes for the conic (1.0) in the case where $C\neq 0$. Starting with a well known identity [2]

$$(A+\delta)l^2+2Hlm+(B+\delta)m^2+2Gl+2Fm+C \tag{3.0}$$
$$=C(lx_1+my_1+1)(lx_2+my_2+1),$$

where (x_1, y_1) and (x_2, y_2) are a pair of foci of (1.0) and

$$\begin{vmatrix} A+\delta & H & G \\ H & B+\delta & F \\ G & F & C \end{vmatrix} = 0. \tag{3.1}$$

From (3.0), by equating coefficients of corresponding powers of l and m, we obtain

$$\begin{aligned} C(x_1+x_2)&=2G, \qquad Cx_1x_2=A+\delta, \\ C(y_1+y_2)&=2F, \qquad Cy_1y_2=B+\delta. \end{aligned} \tag{3.2}$$

Evidently we can form a quadratic equation with roots x_1 and x_2 by making use of (3.2); thus

$$Cx^2-2Gx+(A+\delta)=0,$$

or, since

$$(Cx-G)^2=G^2-C(A+\delta),$$

then

$$(Cx-G)^2=-(\Delta b+C\delta). \tag{3.3}$$

Also, since

$$\begin{vmatrix} A & H & G \\ H & B & F \\ G & F & C \end{vmatrix} =\Delta^2,$$

and

$$AC-G^2+BC-F^2=(a+b)\Delta,$$

(3.1) gives

$$C\delta^2+(a+b)\Delta\delta+\Delta^2=0, \tag{3.4}$$

which may be taken in the form

$$(C\delta/\Delta)^2+(a+b)(C\delta/\Delta)+C=0. \tag{3.5}$$

Since (2.0) may be taken in the form

$$(hm-b)^2+(a+b)(hm-b)+C=0, \tag{3.6}$$

we have from (3.4) and (3.5)

$$C\delta/\Delta = hm - b.$$

The last result, in (3.3), gives

$$Cx - G = \pm\sqrt{-\Delta hm}. \tag{3.7}$$

For *real* foci, choose $m = -1/\phi$ and obtain

$$x = (G \pm K)/C. \tag{3.8}$$

Similarly, we obtain the y values of the *real* foci

$$y = (F \pm \phi K)/C. \tag{3.9}$$

The *directrices* follow immediately from the polar of (x_1, y_1)

$$x(ax_1 + hy_1 + g) + y(hx_1 + by_1 + f) + gx_1 + fy_1 + c = 0. \tag{3.10}$$

Since x_1 and y_1 are given by (3.8) and (3.9), (3.10) becomes

$$\Delta \pm K[x(a + h\phi) + y(h + b\phi) + (g + f\phi)] = 0, \tag{3.11}$$

or,

$$X + \phi Y = \pm K, \tag{3.12}$$

with

$$X \equiv ax + hy + g, \qquad Y \equiv hx + by + f.$$

Returning to (2.9) and making use of (2.11) when the point $(\alpha \cos\theta, \alpha \sin\theta)$ lies on this conic, we immediately obtain

$$\alpha^2 = \frac{-\Delta/C}{a\cos^2\theta + 2h\sin\theta\cos\theta + b\sin^2\theta}. \tag{3.13}$$

Dividing by $\cos^2\theta$ and making use of (2.0) together with the identity $1 + \tan^2\theta = \sec^2\theta$, we have

$$\alpha^2 = \frac{-\Delta}{C(a + h\phi)}. \tag{3.14}$$

Similarly, a simple computation leads to

$$\beta^2 = \frac{-\Delta}{C(b - h\phi)}, \tag{3.15}$$

where α and β are the *lengths of the semi-major and semi-minor axes*, respectively. Since the eccentricity of a conic is given by

$$e^2 = 1 - \beta^2/\alpha^2,$$

the relations (3.14) and (3.15) give immediately

$$e^2=1-(a+h\phi)/(b-h\phi). \tag{3.16}$$

Also, since major and minor axes are perpendicular to each other, it is readily seen that (3.7) and (3.8) lead to the respective *equations for these axes.*

$$\phi Cx-Cy+F-\phi G=0, \tag{3.17}$$

$$Cx+\phi Cy-\phi F-G=0. \tag{3.18}$$

4. In the non-central case, $C=0$. Consequently, when the general equation (1.0) leads to a parabola our results must be altered slightly. Thus, in place of (3.0) we have the identity

$$\begin{aligned}(A+\delta)l^2+2Hlm+(B+\delta)m^2+2Gl+2Fm \\ \equiv(lx_1+my_1+1)(2Gl+2Fm),\end{aligned} \tag{4.0}$$

where (x_1, y_1) are the coordinates of the focus and we place $C=0$ in (3.1). Then

$$2Gx_1=A+\delta, \qquad 2Fy_1=B+\delta, \tag{4.1}$$

and (3.4) becomes

$$(a+b)\delta+\Delta=0, \tag{4.2}$$

or,

$$\delta=-\Delta/(a+b). \tag{4.3}$$

From (4.3) and (4.1) we have the *coordinates of the focus* for the parabola

$$2x_1=[A-\Delta/(a+b)]/G, \qquad 2y_1=[B-\Delta/(a+b)]/F. \tag{4.4}$$

The *directrix* follows immediately from the equation of the director circle

$$C(x^2+y^2)-2Gx-2Fy+A+B=0,$$

which with $C=0$ becomes

$$2Gx+2Fy-(A+B)=0. \tag{4.5}$$

Also, since the vertex lies midway between focus and directrix, the equation of the *tangent through the vertex* is given by

$$2Gx+2Fy-(A+B)+\Delta/(a+b)=0. \tag{4.6}$$

Again, since the axis passes through the focus and is perpendicu-

lar to the directrix, (4.5) and (4.4) lead to the *equation of the axis*

$$(4.7)\qquad 2Fx-2Gy+G[B-\Delta/(a+b)]/F-F[A-\Delta/(a+b)]/G=0.$$

Solving (4.6) and (4.7) we have the *coordinates of the vertex*

$$(4.8)\qquad \begin{aligned} 2x&=[A-\Delta a/(a+b)^2]/G,\\ 2y&=[B-\Delta b/(a+b)^2]/F. \end{aligned}$$

The *latus rectum* is now easily determined to be

$$(4.9)\qquad 4p=\sqrt{-\Delta/(a+b)^3}.$$

The above results are very easy to apply. Naturally, the value of e tells us what the conic may be. The usual scheme for the classification of conics may be given in the following form, but it is to be noted that this latter classification does not give any explicit information as to the value of the principal parts of the conic.

$$F(x,\ y)\equiv ax^2+2hxy+by^2+2gx+2fy+c=0,$$

$$\Delta\equiv\begin{vmatrix} a & h & g\\ h & b & f\\ g & f & c \end{vmatrix},\qquad C\equiv\begin{vmatrix} a & h\\ h & b \end{vmatrix},\qquad I\equiv a+b,$$

$$J\equiv ab+bc+ca-f^2-g^2-h^2.$$

<table>
<tr><td></td><td colspan="2">$C>0$</td><td>$C<0$</td><td colspan="2">$C=0$</td></tr>
<tr><td rowspan="3">$\Delta\neq 0$</td><td>$I\Delta<0$</td><td>Ellipse</td><td rowspan="3">Hyperbola</td><td colspan="2" rowspan="3">Parabola</td></tr>
<tr><td>$I\Delta<0$
$a=b$
$h=0$</td><td>Circle</td></tr>
<tr><td>$I\Delta>0$</td><td>No locus</td></tr>
<tr><td rowspan="3">$\Delta=0$</td><td colspan="2" rowspan="3">A point</td><td rowspan="3">Two intersecting lines</td><td>$J<0$</td><td>Two parallel lines</td></tr>
<tr><td>$J=0$</td><td>Two coincident lines</td></tr>
<tr><td>$J>0$</td><td>No locus</td></tr>
</table>

5. We shall consider two examples here of the preceding discussion.

Example 1.

$$x^2-4xy-2y^2+2x-8y-2=0.$$

$$\Delta=\begin{vmatrix} 1 & -2 & 1 \\ -2 & -2 & -4 \\ 1 & -4 & -2 \end{vmatrix}, \qquad \begin{aligned} G&= 10, & gG&= 10, \\ F&= 2, & fF&= -8, \\ C&= -6, & cC&= 12, \\ & & \Delta&= \overline{14}, \\ & & h\Delta&= -28. \end{aligned}$$

Since $\Delta\neq 0, C<0$, the conic is a hyperbola. Also, by (2.0): and (2.2),

$$-2m^2+3m+2=0, \qquad \phi=-1/2, \qquad K=\sqrt{56}.$$

Center:

$$x_0=-5/3, \qquad y_0=-1/3.$$

Equation of conic with center at (x_0, y_0):

$$x^2-4xy-2y^2-7/3=0.$$

Foci:

$$x=-(10\pm\sqrt{56})/6, \qquad y=-(2\mp\sqrt{56}/2)/6.$$

Directrices:

$$2x-y+3=\pm 56.$$

Transverse axis:

$$\alpha^2=7/6, \quad \text{so that} \quad \alpha=\sqrt{7/6}.$$

Also,

$$\beta^2=-7/9.$$

Eccentricity:

$$e^2=1-\frac{-7/9}{7/6}=15/9, \qquad e=\sqrt{15}/3.$$

Equation of transverse axis:

$$3x+6y+7=0.$$

Equation of conjugate axis:

$$2x-y+3=0.$$

Example 2.

$$x^2+2xy+y^2-2x+6y-2=0.$$

$$\Delta = \begin{vmatrix} 1 & 1 & -1 \\ 1 & 1 & 3 \\ -1 & 3 & -2 \end{vmatrix}, \qquad \begin{aligned} G &= 4, & gG &= -4, \\ F &= -4, & fF &= -12, \\ C &= 0, & cC &= 0, \\ & & \Delta &= -16, \\ & & h\Delta &= -16. \end{aligned}$$

Since $\Delta \neq 0$, $C = 0$, the conic is a parabola.
Focus:

$$x_1 = -3/8, \qquad y_1 = -5/8.$$

Directrix:

$$4x - 4y + 7 = 0.$$

Tangent at vertex:

$$4x - 4y + 3 = 0.$$

Principal axis:

$$x + y + 1 = 0.$$

Vertex:

$$x = -7/8, \qquad y = -1/8.$$

Latus rectum:

$$4p = \sqrt{2}.$$

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NOW IS THE TIME

Your country is at war. These are the harsh facts: Every able-bodied boy in your school must look forward to eventual military service; every girl must look forward to some form of war work. It is your business to educate the youth of the nation for war. Whatever handicaps you in doing that job, whether it be venerable traditions, limitations of time, shortages of manpower, personal inconveniences, or other obstacles, must be removed. This is not the time to be satisfied with the usual program of education. *Now is the time* to adapt, expand, and improve the educational services to our embattled nation.

HUMANIZING SCIENCE AND MATHEMATICS BY COMMEMORATING NOVEMBER ANNIVERSARIES

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The encouragement of confidence in scientific method and the development of facility in its use are perhaps the most discussed and the least implemented aims of science and mathematics instruction in the secondary schools of America at the present time. Teachers in their lectures extol scientific method as means of solving problems, but their teaching methods seldom encourage young people to solve problems scientifically. Textbooks purporting to aid in clarifying the elements of scientific method are widely used. The terms defining the "steps" in the scientific solving of a problem have been carefully memorized by students and are glibly used in classroom discussion. Certainly the parlance related to scientific method has found a place in our classrooms. But teachers and pupils seldom solve problems scientifically.

Such a situation can be traced to several conditions. In the first place teachers as a group have not clarified their own thinking about the meaning of scientific method. True, they have memorized a list of "elements" which characterize a scientific method and they have read glowing descriptions of the achievements of scientific method. But they have seldom participated in the scientific solution to a problem, nor have they even studied the approaches of others in their use of scientific method. In the second place, much of science does not illustrate the on-going processes of its method. The symbols and the concepts of scientists easily become divorced from human experience. The machines which represent in their construction the application of scientific methods of thinking do not require in their operation the use of scientific method. In short science is easily formalized and mechanized. Such a science can do many routine things, but it cannot instruct pupils in the meaning and use of scientific method. In the third place, teachers fail to realize that they cannot teach scientific method to anyone. Thinking of scientific method in the abstract, they fail to see that scientific method is a way of solving problems. Pupils must have experience in solving problems scientifically if scientific method is to be understood. In the fourth

place, the extent to which scientific method is used in America today is limited. Scientists and engineers in their laboratories use it, but they seldom extend it to other areas of human living. Decisions in the economic and social world are seldom reached in a scientific manner. Hence, students seldom have the opportunity of solving problems scientifically in the affairs of everyday life.

It would seem then that if teachers wish to encourage confidence in scientific method and to develop facility in its use, they must first cultivate for themselves and for their pupils a deeper insight as to the real nature of science. They must discover that in the past what we now call science was actually embodied in living human beings, and not in formulas, principles, laws, and the abstractions of men. They must realize that real science is not dead; that great scientific discoveries were not made by the application of mathematical formulas; that the heart of creative science is the flash of insight which comes, we know not how, after struggling with a real problem. Certain we are that the whole process centers in a *man*, a scientist we call him, not in a definition, not in a formula, not in an inanimate machine. In short, if teachers are to develop an understanding of and appreciation for the methods of the scientist, they must *humanize* their teaching of science and mathematics.

To humanize science and mathematics is to put the center, the *human* element, squarely in the picture. We cannot divorce true science or mathematics from an on-going human activity. This is the activity of the scientist and of the mathematician. Too often people think of science and mathematics as bodies of complete and irrefutable facts; too seldom do they sense the excitement of guessing and checking which holds the interest of the scientist and mathematician. J. W. L. Glaisher has wisely said: "I am sure that no subject loses more than mathematics by any attempt to dissociate it from its history." And so with science in general.

However, we must not mistake antiquarianism for history. We are not concerned primarily with the date of birth, the nationality, the discoveries, or the inventions of a scientist or mathematician. It is imperative that we have a living acquaintance with the man—his problems, his guesses, his mistakes, his successes—in short his method of solving problems, his attempts to cultivate a scientific attitude toward his difficulties.

How are pupils and teachers to secure this living acquaintance

with the methods of solving problems used by scientists and mathematicians? How can science and mathematics be humanized? The author has no panacea to offer in answer to the above questions. However, experience with the activities suggested in the remainder of this paper has convinced the author that they are at least potentially useful for helping young people to relive the failures and successes of the men and women who have contributed to the development of a method of solving problems which has become known as scientific method.

The arrangement of the activities is partly chronological, partly topical. Each teacher should fit the activities in a sequence of his own choosing. However, there is something human about birthdays; young people like to celebrate them. This psychological fact suggested a chronological organization for the activities. The advantages of a topical arrangement are too obvious to need justification.

Scientists of the Month

As part of an earlier article (*27:* 615–616)* the author suggested some bulletin board activities to commemorate the anniversaries of a given month. Such books as those by Douglas (*7*) and Hazeltine (*9*), the Telephone Almanac (*25*), and the author's more extended calendar (*26*) will be helpful in selecting the scientists and mathematicians for these activities.

Scientists of the Year

Almost every year is a centennial year in science and mathematics. Thus, 1942 is the golden anniversary of the birth of the physicist Arthur Holly Compton. It is the centennial of the birth of Lord Rayleigh, of the enunciation of the Doppler Principle, of the publication of Mayer's Principle of the Conservation of Energy, of the first recorded use of an anaesthetic in an operation, of Charles Thomas Jackson's experiments with the anaesthetic properties of sulphuric ether, of Asa Gray's election to the Fisher professorship at Harvard University, and of the birth of Sir James Dewar. It is the sesqui-centennial of the birth of the biologist Karl Ernest von Baer, of the birth of the astronomer Sir John Herschel, and of the birth of Charles Babbage, the English mathematician. It is the ter-centennial of

* The first or italic number refers to the aids listed in the bibliography which concludes this article, and the second group of light-face figures, if any, identifies the pages. In the bibliography complete data concerning the materials and ways of securing them are given.

the birth of Sir Isaac Newton. It is the sesqui-quadrennium of the discovery of America by Columbus. Students gain perspective by noting such anniversaries as these.

Each year numerous awards are made to scientists. Thus in 1942 George Washington Carver was named the "man of the year" by the *Progressive Farmer*, a southern magazine. Here is an excellent opportunity for pupils and teachers to pause and ask themselves why this particular man has been so honored. An answer to this question in the case of Carver is dramatically portrayed in the film entitled *The Story of Doctor Carver* (*40*).

That Men May Live

November first is doubly appropriate for commemorating the centennial of the first recorded use of an anaesthetic in an operation. For on this day in 1815 Crawford Williamson Long was born at Danielsville, Georgia. It was Long who first administered ether in an operation in 1842. This event is portrayed in a film entitled *Anesthesia* (*36*). In contrast to operations with anaesthetics, the film *One Against the World* (*37*) shows Ephraim McDowell in his fight to perform the first ovariotomy without an anaesthetic. Since McDowell was born on November 11, 1771 in Rockbridge County, Virginia, it seems appropriate to show the film on the anniversary of his birth.

Non-Euclidian Geometry

On November 2, 1793 Nicolai Ivanovich Lobachevski was born in Makariev, Nizhni-Novgorod, Russia. W. K. Clifford has called him "the Copernicus of Geometry." Why? Eric Bell (*1*:294–306) in his inimitable style has suggested some reasons.

The materials for a bulletin board display contrasting the geometry which follows from the acceptance of Euclid's parallel postulate with that which is necessitated by its rejection exist in the sketches given in the chapter together with a portrait of Lobachevski (*1*: 298). Twenty-eight other portraits are included in the book. Since these are full page plates, they can be easily detached without injury to the book, mounted, and filed for bulletin board use on appropriate occasions. The book can be kept on the classroom bookshelf for student use. A portrait of Euclid (*29a*) can be used to carry out the contrast.

Radium and Embryos

On November 7, 1867 Marie Sklodowska Curie was born in

Warsaw, Poland and on the same day twenty-seven years before Alexander Kovalevsky first saw the light of day in Dünaberg, Russia. However, these two scientists have more than their birthdays in common. They are partners, this physicist and chemist and this embryologist, seeking to discover some fundamental relations in the seeming complexity of nature. Their brilliant researches can be well studied by any who would understand and appreciate the methods of science.

Materials for a report on Kovalevsky will be found in Wagenen (*22:* 385–386) and in the *Britannica* (*8*).

An imposing array of materials is easily accessible for a study of the methods of Marie Curie. Students can dramatize the story of the discovery of polonium and of radium from the materials contained in the biography of Madame Curie by her daughter Eve (*5:* 152–177). This book also contains thirty-one full page illustrations which can be detached without injury to the book for a bulletin board display on the life of this great scientist. Other pictures of Madame Curie will be found in Bridges and Tiltman (*2:* 66), Darrow (*6:* 238) and Jaffe (*12:* 247, 262). A pamphlet (*24*) containing an adaptation of Madame Curie's life as written by her daughter is available. A film strip (*31*) dealing with her life may be had at no cost to the school. A teachers' guide (*23*), is available for the pamphlet and the film strip. The story of the discovery of radium has been filmed (*38*) and Marie's biography has been dramatized in a recording (*32*).

The Discovery of Argon

Just as the discovery of radium was the most spectacular event in Madame Curie's career, so also the discovery of another element, argon, was the most dramatic event in Lord Rayleigh's scientific career. An excellent illustration of scientific method is contained in the biography of Lord Rayleigh by his son (*17:* 187–225). Since November 12, 1942, is the centennial day, month, and year of Rayleigh's birth, these materials would be useful for preparing a radio dramatization to commemorate the event. A report on Rayleigh's "redetermination of the electrical standards" (*17:* 109–127) would give students the distinction between fundamental units like the meter and derived units like the ohm. This book (*17*) also contains five plates suitable for a bulletin board display on the life of Lord Rayleigh. These are easily detached without injury to the book. A photogravure portrait of Lord Rayleigh (*30*) for framing is

also available. Students could get permission to name their physics laboratory the "Rayleigh Laboratory of Physics" and present this picture framed to the school for hanging in the laboratory.

Pressure and Temperature

On the same day in November on which Lord Rayleigh was born but 96 years before, Jacques Alexandre César Charles was born in Beaugency, France. A report on the scientific activities of Charles (*8*) will show that he is remembered for other things than the famous law which carries his name.

November fifteenth is the anniversary of a famous letter (*19:* 94–95) for on that date in 1647 Blaise Pascal wrote to his brother-in-law, Florin Périer and asked him to check his prediction that "air pressure at the summit of a mountain would be less than in the valley below." It would only take a few minutes to read this letter to a class to show how a scientist subjects his guesses to empirical investigation.

November is the anniversary of the birth of still another pioneer in pressure and temperature measurements, for on November 27, 1701, Anders Celsius was born at Uppsala, Sweden. A report on the life of Celsius (*8*) should show how an astronomer gave science the Centigrade scale.

Magdeburg and Wittenberg

We could have included the "Mayor of Magdeburg" as a pioneer in pressure and temperature investigations also. However, as Crowther (*4:* 354–362) has shown this civic-minded scientist was a very versatile man, so we have preferred to include him along with one of his fellow countrymen as a pioneer in acoustic investigations. Students could well repeat some of his famous experiments on the 340th anniversary of his birth, November 20, 1942. These are described in almost any physics textbook.

Today the cities of Germany are front-page news because of the "blockbuster" bombs which the United Nations are delivering to them. This is essential to win the war. But if we would win the peace, our students must also make other associations with these historic cities. And so we would do well to remind our students that not only Magdeburg but Wittenberg also gave us a pioneer in acoustic investigations. For on November 30, 1756, "The Father of Modern Acoustics," E. F. F. Chladni, was born

there. A demonstration of the famous "Chladni figures" (*22:* 207–209) would serve to commemorate his anniversary. Your physics textbook should show you how to produce these.

Diabetes and Insulin

November fourteenth is the anniversary of the birth of three scientific pioneers from Canada, Pennsylvania, and Belgium respectively: Frederick Grant Banting, Robert Fulton, and Leo Hendrik Baekeland. In 1942 we commemorate the 51st anniversary of Banting's birth, the 177th anniversary of Fulton's birth, and the 79th anniversary of Baekeland's birth.

The film *They Live Again* (*41*) will help us to relive the famous experiments of Sir Frederick Banting in his quest to find a cure for diabetic sufferers. The story of the discovery of insulin is also available in a non-royalty radio play by Vernon Delston (*15:* 664–667) which students will enjoy performing. The relation of Banting's work to the sum total of glandular research is shown in Jaffe (*13:* 174–177).

Heat and Work

In commemoration of the anniversary of Fulton's birth a student report on the building of the "Clermont" would be appropriate. The plan of the "Clermont" as reproduced by the Hudson-Fulton Celebration commission in 1907 is available in Iles (*11*: 62). Perhaps a student will want to build a model of this early steamboat and use it in presenting a report to the class. The materials in Iles (*11:* 40–74) and Hylander (*10:* 45–58) will be useful for this purpose. A bulletin board display can be planned with the portrait in Iles (*11:* 40) or that in the Perry Pictures (*28*) and the sketches of Fulton's boats given in Hylander (*10:* 49, 55, 57). The portrait in Iles can be detached without injury to the book, but the sketches in Hylander will have to be redrawn by students since they are too small for a bulletin board display.

Although Fulton utilized the power of steam to propel a boat, it was not until 1842 that Robert Mayer published his paper entitled "The Forces of Inorganic Nature" which contains the first calculation of the mechanical equivalent of heat and the great principles of the Law of the Conservation of Energy. Since Mayer was born on November 25, 1814 and since 1942 is the centennial of the publication of his paper, it is doubly significant to commemorate the anniversary of his birth. Here is an

excellent opportunity to show how the more sordid of human traits characterize even those who attempt to develop scientific attitudes. The shameful story of the reception of Mayer's paper is well told by Trattner (*21:* 137–143).

The Romance of Science

The third of our trio of scientific pioneers who was born on November fourteenth is Leo Hendrik Baekeland. His discovery of *The Fourth Kingdom* (*39a* or *39b*) is graphically portrayed in the film of that title. This is the story of the development of "Bakelite materials and the rapid expansion of uses for these man-made products since that day in 1909 when Dr. L. H. Baekeland first announced his discovery of phenol resinoid and thereby created a new industry."

If Baekeland created a new industry in plastics, Sir Robert Abbot Hadfield, who was born November 29, 1859 in Sheffield, England, must be given a large share of the credit for developing *Alloy Steels* (*35*). His contribution is portrayed in the film of that title.

While Baekeland and Hadfield found romance in applied chemistry, one of Hadfield's countrymen, Henry G. J. Moseley found the theoretical aspects of physics exciting. In these days when war again is exacting its toll among our young scientists, and in commemoration of the anniversary of his birth, November 23, 1887, we may well pause and recall his brilliant yet tragic story (*12:* 289–311). Jaffe (*12:* 310) includes a portrait of Moseley at his desk with his books. This may be easily detached without injury to the book and used for a bulletin board display.

A Versatile Mathematician

On the same day of the month that Moseley was born but 271 years before his countryman, John Wallis, was born. A report on the story of his life (*8*) will show the many aids which he contributed to the advancement of mathematics and through it to science.

An American Botanist

We have already called attention to 1942 as the centennial of Asa Gray's election to the Fisher professorship at Harvard University. Gray was born in Paris, New York on November 18, 1810. This double anniversary could well be commemorated by arranging an exhibit of Gray's textbooks in botany if the

materials are available in your local library. A brief report on his life (*8*) would also be appropriate.

Light, Telescopes, and Galaxies

We have previously noted that 1942 is the centennial of the enunciation by Christian Doppler of the principle that "the light emitted from an object receding from an observer should appear of lower frequency and the light from an object approaching the observer should appear of higher frequency than the light from the same object when stationary." Moreover, November, in addition to being the anniversary of Doppler's birth, is the anniversary of the births of five other scientists whose work has enabled man to make the light received through his telescopes reveal the secrets of distant galaxies. Sir William Herschel, who was born November 15, 1738, was a pioneer in the extension of man's sense of space. Louis J. M. Daguerre was born November 18, 1789, and is a pioneer in the development of photography which has found so many applications in astronomy. John Alfred Brashear played an important part in the construction of telescopes and their accessories in America following his birth on November 24, 1840. It was Brashear who made the diffraction gratings which another American, Henry Augustus Rowland, had perfected in the years since his birth on November 27, 1848. And it is Edwin Powell Hubble, who was born in Marshfield, Missouri on November 20, 1889, standing upon the shoulders of these mental giants who has received light from those distant galaxies which Herschel saw only in his imagination. It is just 151 years from the birth of Herschel to that of Hubble, just 100 years from Daguerre's birth to that of Hubble, and in the interval man developed the instruments and the techniques which bring distant galaxies within his comprehension.

Here then is an excellent example of the unity and interdependence of science. So the poet, Alfred Noyes, reminds us: "The story of scientific discovery has its own epic unity—a unity of purpose and endeavor—the single torch passing from hand to hand through the centuries; and the great moments of science when, after long labour, the pioneers saw their accumulated facts falling into a significant order—sometimes in the form of a law that revolutionized the whole world of thought—have an intense human interest, and belong essentially to the creative imagination of poetry." (*16:* v) Noyes has captured

some of these movements for us in his poem *Watchers of the Sky* (*16*). On the anniversary of Herschel's birth give your class an insight into one of these great moments as "William Herschel Conducts" (*16:* 231–243). For an astronomer's estimate of Herschel's work, have a report based on Jones (*14:* 1–4).

The contributions of Daguerre to the development of photography may be traced in Burlingame (*3:* 253–286) and in Darrow (*6:* 131–135). Darrow (*6:* 132) contains a portrait of Daguerre. If the materials are available in your community an exhibit of Daguerreotypes would be appropriate for commemorating the anniversary of his birth.

The chapter entitled "Making the First Telescope" in Brashear's *Autobiography* (*18:* 31–38) is a good introduction to his life. This reading may lead to an interest on the part of some students in the making of a telescope for the school. The book (*18*) also contains 24 full page plates which can be detached without injury to it. These can be used effectively in a bulletin board display. The story of Brashear's visit to the Herschel home in Slough, England (*18:* 101–104) is worthy of a report to the class. The sonnet (*18:* v) dedicated to Brashear is also worth reading to the class.

Brashear's *Autobiography* is useful in studying the work of Rowland. The chapter entitled "The Rowland Diffraction Gratings" (*18:* 73–79) has excellent material for a report on the relations of these two great Americans. This can be supplemented by the material in the *Britannica* (*8*) and in Wagenen (*22:* 403–404). As was suggested with Rayleigh, students may wish to obtain permission to name their physics laboratory "The Rowland Laboratory of Physics." They could then frame a portrait (*29b*) and present it to the school for the laboratory. Perhaps students will want to explore the merits of various physicists before deciding on a name for their laboratory. Here is an excellent opportunity for the teacher to guide the development of the critical abilities of his pupils.

Jaffe (*13:* 485–516) has done a excellent job in showing the relation of Doppler's principle to the researches of Hubble at Mount Wilson Observatory. This book also contains a portrait of Hubble (*13:* 490) and a photograph of the Mount Wilson telescope (13*:* 506). These can be used for a bulletin board display. To complete this exhibit the photographs in *Life* for October 20, 1941 on "The Galaxies" would be excellent.

The Atlantic Cable

While Hubble and his associates have extended man's perspective in space, a host of improvements in man's method of communication have brought him into closer relations with his earth. Cyrus West Field, the financier who projected the Atlantic Cable, was a pioneer in these developments. The anniversary of Field's birth, November thirtieth, is an appropriate occasion to recall the story of the laying of the Atlantic Cable and its social consequences. Burlingame's chapter on "Entangling Alliances" (*3:* 10–25) is valuable for this purpose. Sufficient sketches are included for a cartoon history of the event if students are talented in sketching. Youngsters in the junior high school will enjoy hearing the poem "How Cyrus Laid the Cable" (*20:* 565) or Whittier's "The Cable Hymn" (*20:* 565). A recording (*34*) of Edison's speech at the 1908 New York Electrical Show commemorating the fiftieth anniversary of the laying of the first Atlantic Cable is also available.

Sir John Ambros Fleming, who was born November 29, 1849 in Lancaster, England, added another significant chapter to the development of communication. A report tracing his contributions (*8*) would be fitting to commemorate the anniversary of his birth.

The Gospel of Wealth

Just as Field was a financier rather than a scientist, so too is the last of the notables whom we have chosen to represent November anniversaries. Andrew Carnegie was born in Dunfermline, Scotland on November 25, 1835. We have chosen to include this pioneer steelmaster in the list of our scientists because of the many institutions for research which he created. A panel discussion on the role of capital in scientific progress would be a fitting commemoration of the anniversary of his birth. You can hear Carnegie's own *Gospel of Wealth* (*32*) on a recording, and you can read of his many philanthropic enterprises in the *Britannica* (*8*).

The above are only a few of the many anniversaries which may be commemorated in November. A more extended list is available in the author's "Calendar of the Birthdays of Scientists" (*26*). Moreover the activities suggested for any anniversary can be extended and supplemented in many ways. However, they are representative of the kinds of materials which are

available to aid teachers in the humanizing of science and mathematics. No one teacher would want to commemorate all of the anniversaries or to utilize all of the activities listed for a particular anniversary; but it is the author's hope that every science and mathematics teacher will select at least one November anniversary and commemorate it in an appropriate manner. To facilitate the planning of these projects, this paper is concluded with a calendar of the birthdays mentioned, a chronology of the birth years to which reference has been made, a classified bibliography of the instructional aids utilized in the activities, and a key to the producers and distributors of these aids.

Calendar of November Birthdays

1 Long	14 Baekeland	20 Hubble	27 Rowland
2 Lobachevski	14 Banting	23 Moseley	29 Doppler
7 Curie	14 Fulton	23 Wallis	29 Fleming
7 Kovalevsky	15 Herschel	24 Brashear	29 Hadfield
11 McDowell	18 Daguerre	25 Carnegie	30 Chladni
12 Charles	18 Gray	25 Mayer	30 Field
12 Rayleigh	20 von Guericke	27 Celsius	

Chronology of Birthyears

c. 300 B.C. Euclid

1602 von Guericke	1803 Doppler	1848 Rowland
1616 Wallis	1804 Kovalevsky	1849 Fleming
1701 Celsius	1810 Gray	1859 Hadfield
1738 Herschel	1814 Mayer	1863 Baekeland
1746 Charles	1815 Long	1864 (?) Carver
1756 Chladni	1819 Field	1867 Curie
1765 Fulton	1835 Carnegie	1887 Moseley
1771 McDowell	1840 Brashear	1889 Hubble
1789 Daguerre	1842 Rayleigh	1891 Banting
1793 Lobachevski		

AUDIO-VISUAL AIDS FOR HUMANIZING SCIENCE AND MATHEMATICS

I. Books Containing Aids

1. Bell, Eric Temple, *Men of Mathematics*. New York: Simon and Schuster, 1937. xxi+592 pp.
2. Bridges, T. C. and Tiltman, H. H., *Master Minds of Modern Science*. New York: The Dial Press, 1931. 278 pp.
3. Burlingame, Roger, *Engines of Democracy*. New York: Charles Scribner's Sons, 1940. xviii+606 pp.
4. Crowther, J. G., *The Social Relations of Science*. New York: The Macmillan Company, 1941.
5. Curie, Eve, *Madame Curie*. (Vincent Sheean, Tr.) New York: The Literary Guild of America, Inc., 1937. xi+393 pp.
6. Darrow, Floyd L., *Masters of Science and Invention*. New York: Harcourt, Brace and Company, 1923. vi+352 pp.
7. Douglas, George William, *The American Book of Days*. New York: H. W. Wilson Company, 1940.

8. *Encyclopaedia Britannica*, The (Fourteenth Edition, 1937). London: The Encyclopaedia Britannica Company, Ltd., 1937.
9. Hazeltine, Mary Emogene, *Anniversaries and Holidays*. Chicago: American Library Association, 1928.
10. Hylander, C. J., *American Inventors*. New York: The Macmillan Company, 1934. xvi+216 pp.
11. Iles, George, *Leading American Inventors*. New York: Henry Holt and Company, 1912. xvi+447 pp.
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15. Kozlenko, William, (Comp.), *One Hundred Non-Royalty Radio Plays*. New York: Greenberg Publisher, Inc., 1941.
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18. Scaife, W. Lucien, (ed.), *John A. Brashear*. New York: The American Society of Mechanical Engineers, 1924. xxiv+262 pp.
19. Schuster, M. Lincoln, (ed.), *A Treasury of the World's Great Letters*. New York: Simon and Schuster, Inc., 1940.
20. Stevenson, Burton Egbert, (ed.), *Poems of American History*. New York: Houghton Mifflin Company, 1908.
21. Trattner, Ernest R., *Architects of Ideas*. New York: Carrick and Evans, Inc., 1938. 426 pp.
22. Wagenen, Theo. F. Van, *Beacon Lights of Science*. New York: Thomas Y. Crowell Company, 1924. xvi+444 pp.

II. Pamphlets Containing Aids

23. Bailey, Edna W., *Biographical and Scientific Material in Health Teaching*. New York: Metropolitan Life Insurance Company, N.D. 54 pp. One free to each teacher.
24. Hallock, Grace T., (comp.), *Marie Curie*. New York: Metropolitan Life Insurance Company, N.D. 31 pp. Free copy for each pupil.
25. *Telephone Almanac, 1942*. New York: American Telephone and Telegraph Company, 1942. 32 pp. One free to each teacher.

III. Recent Periodicals Containing Aids

26. Teller, James D., "A Calender of the Birthdays of Scientists," SCHOOL SCIENCE AND MATHEMATICS. Vol. 41, pp. 614–615, 768, 884–885; Vol. 42, pp. 87–88, 187–188, 207–208, 312–314, 490–492, 574–576, October 1941–June 1942.
27. Teller, James D., "Humanizing the Teaching of Science by Using the Bulletin Board," SCHOOL SCIENCE AND MATHEMATICS. Vol. 41, pp. 611–619, October, 1941.

IV. Flat Pictures

28. Photogravure of John William Strutt Rayleigh (*Scientific Worthies Series*). Available from MC.*
29a. Portrait of Euclid (*Portraits of Eminent Mathematicians* series). 10×14 inches. Available from SM.

* See key to sources of these aids which follows this bibliography.

29b. Portrait of Henry A. Rowland (*Portraits of Famous Physicists* series). 10×14 inches. Available from SM.

30. Portrait of Robert Fulton. ("Teller set of 30 Science Teachers' Collection of Pictures"). 5½×8 inches. Available from PPC.

V. Film Strip

31. *Madame Curie and the Story of Radium* (Health Heroes series). Available from MLI.

VI. Recordings

32. *Madame Curie.* One 16 inch record, two sides, 30 minute program at 33⅓ r.p.m. Available from EDR at a cost of $7.50.

33. *The Gospel of Wealth* (*Voices from History* series). One 12-inch record, two sides, 8 minute program at 78 r.p.m. Available from GR at a cost of $1.50.

34. *Thomas Alva Edison* (*Voices from History* series). One 12-inch record, two sides, 8 minute program at 78 r.p.m. Available from GR at a cost of $1.50.

VII. Motion Picture Films

35. *Alloy Steels: A Story of Their Development.* One 16 mm. sound reel in black and white, 20 minute program. Available from USBM, Kan, NJ, NWBM, Mil.

36. *Anesthesia* (MGM Pete Smith Specialties series). One 16 mm. sound reel in black and white, 10 minute program. Available from TFC, Ohio, YMCA (rental).

37. *One Against the World* (MGM Passing Parade Series). One 16 mm. sound reel in black and white, 11 minute program. Available from TFC.

38. *Romance of Radium* (MGM Pete Smith Specialties Series). One 16 mm. sound reel in black and white, 10 minute program. Available from TFC, Ohio, Bos U.

39a. *The Fourth Kingdom.* Three 16 mm. sound reels in black and white, 30 minute program. Available from YMCA (loan), Minn., Wis., Geo., Ill., Kan., Okla.

39b. *The Fourth Kingdom.* Three 16 mm. silent reels in black and white, 30 minute program. Available from YMCA (loan), Minn., Wis.

40. *The Story of Doctor Carver* (MGM Pete Smith Specialties Series). One 16 mm. sound reel in black and white, 10 minute program. Available from TFC, Ohio, Bos U, YMCA (rental).

41. *They Live Again* (MGM Miniature series). One 16 mm. sound reel in black and white, 11 minute program. Available from TFC, Ohio, Bos U, Geo, Ill, Ind, Mich, Minn, NC, Okla, PCW, Tenn, Wis, YMCA (rental).

Key to Sources of Audio-Visual Aids

Bos U — Boston University, School of Education, 84 Exeter Street, Boston, Massachusetts. Sound films are rented at $1.50 a reel per day. Transportation charges in both directions are paid by the user.

EDR — Eccles Disc Recordings, Inc., Pantages Theater Building, Hollywood, California.

Geo — University System of Georgia, Division of General Extension, 223 Walton Street, N.W., Atlanta, Georgia. Films are rented at rates which range from $.75 to $2 per title. Transportation charges in both directions are paid by user.

GR General Records Company, 1600 Broadway, New York, New York.

Ill University of Illinois, Visual Aids Service, 1206 W. Springfield Avenue, Urbana, Illinois. Films are rented at rates which range from $.50 to $10. Transportation charges in one direction are paid by the user.

Ind Indiana University, Extension Division, Bloomington, Indiana. Groups in Indiana may rent reels for $.75 each. Groups outside the state may rent reels for $1 each per day. Users pay transportation charges in both directions.

Kan University of Kansas, Bureau of Visual Instruction, University Extension Division, Lawrence, Kansas. Films are loaned on payment of a service charge. Borrower pays transportation costs both ways.

MC Macmillan Company, 60 Fifth Avenue, New York, New York. Photogravures in the "Scientific Worthies" series are available at $2.50 each. Order by name of portrait desired.

Mich University of Michigan, Ann Arbor, Michigan. Film service is available at nominal but variable rentals. Borrower pays transportation charges in one direction.

Mil Milwaukee Public Museum, Loan Service, Department of Extension, Milwaukee, Wisconsin. Films are loaned if borrower agrees to pay transportation costs both ways.

Minn University of Minnesota, Bureau of Visual Instruction, Minneapolis, Minnesota. Film service is available at nominal but variable rentals. Users pay transportation charges in both directions.

MLI Metropolitan Life Insurance Company, New York, New York. One film strip of each of seven "health heroes" is available free to each school.

NC University of North Carolina, Extension Division, Chapel Hill, North Carolina. Film service is available at nominal but variable rentals.

NJ New Jersey State Museum, State House Annex, Trenton, New Jersey. Films are loaned if borrower agrees to pay transportation costs both ways.

NWBM Bureau of Mines, Northwest Experiment Station, University of Washington, University Campus, Seattle, Washington. Films are loaned if borrower agrees to pay transportation costs both ways.

Ohio Ohio Department of Education, State Office Building, Columbus, Ohio. Film service is available without cost to Ohio public and parochial schools only. Transportation costs in both directions are paid by the user.

Okla University of Oklahoma, Bureau of Visual Education, Norman, Oklahoma. Film service is available at nominal but variable rentals. Users pay transportation charges in both directions.

PCW Pennsylvania College for Women, Pittsburgh, Pennsylvania. Film service is available to Pennsylvania and neighboring states at rates which range from $.35 to $2.50 per reel with the user paying transportation charges in both directions.

PPC The Perry Pictures Company, Malden, Massachusetts. Thirty $5\frac{1}{2} \times 8$ inch pictures to aid in humanizing the teaching of science are available. Order the "Teller set of 30 Science Teachers' Collection of Pictures." Send 60 cents in stamps or money order with your request.

SM Pictorial Mathematics, c/o Scripta Mathematica, 186th Street and Amsterdam Avenue, New York, New York. In series I a collection of 37 portraits is available. Single portraits are 50 cents, in lots of 5 or more each portrait is 35 cents; the whole collection of 37 portraits is 7 dollars. A portfolio of 12 "Portraits of Famous Physicists" may be purchased for $3.75; a portfolio of 13 "Portraits of Eminent Mathematicians" may be had for $3.00.

Tenn University of Tennessee, Division of University Extension, Knoxville, Tennessee. Film service is available at rates which range from $.25 to $3.50 for one day.

TFC Teaching Film Custodians, Inc., 25 West 43rd Street, New York, New York. Schools desiring to license films for classroom use should indicate in a letter the subjects desired and the dates for which bookings are to be made. Copies of the license agreement will then be mailed to the school. The license fee per reel of black and white films for a period of two weeks or less is $5. Transportation costs in both directions are paid by the user.

USBM Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh, Pennsylvania. Films are loaned if borrower agrees to pay transportation costs both ways.

Wis University of Wisconsin, Madison, Wisconsin. Film service is available with service charges ranging from $.15 to $7. Users pay return transportation.

YMCA National Council of Young Men's Christian Associations, Motion Picture Bureau, 347 Madison Avenue, New York; 1700 Patterson Avenue, Dallas; 19 South La Salle Street, Chicago; 351 Turk Street, San Francisco. Rental films are rented at $1.50 a reel per day. Loan films are loaned free on payment of an annual registration fee of $2. In either case the user pays transportation charges both ways.

WAR AND EDUCATION

War is destructive, destructive of young lives, of homes, of friendships, of hopes, of ideals. It is destructive also of false prides, special privileges, unworthy ambitions, decadent institutions. It is a fire that consumes rubbish and weeds as well as flowers. When it passes what is best in human nature often attains ascendancy for a time—the pendulum swings from the guillotine to liberty, equality and fraternity.

Education in the United States is beginning to feel the effects of the war. The incomes of endowed institutions are declining, the faculties of universities and colleges are being depleted by demands for specialists from the Government, teachers in elementary and secondary schools, women as well as men, are giving up their professions to enter war industries or governmental service. Registrations in universities and colleges are declining, and colleges and universities are being taken over in part by the War and Navy departments. Young men, who in times of peace would be finishing their education, are driving tanks or flying planes in Australia or Africa or Europe or Asia; young women are leaving their classes for nursing or work in the Red Cross or to marry young men who are about to go overseas. American education is one of the casualties of the present war.

—*AAAS Bulletin*

AVIATION MATHEMATICS

LILLIAN MOORE
Far Rockaway High School, New York, New York

In a recent article, "Task Force," in the April 6, 1942 issue of *Life Magazine*, there appeared a photograph of the thirty-eight men who fly and service one big bomber. A flight crew of nine and a ground crew of eleven men work on one plane only. Twenty men are needed for one plane. Everyone now realizes the importance of adequate air support for our army and navy. The setbacks of the United Nations in the Far East have been due to lack of air superiority. In order to win this war, we need planes and men to fly the planes. The planes are rolling off the assembly lines in California, Michigan and New York. Will we have a sufficient number of trained men ready to fly and service these planes?

It is the job of the high schools to give the preparatory training which will insure an adequate supply of such men for the armed forces. The youth of the country must become "air-conditioned." No one is better prepared to assist in developing a realization of the importance of aircraft and flying in war than the secondary-school teacher of mathematics. It is to be sincerely hoped that he will grasp the opportunity before it is "too late." Fortunately many teachers of mathematics throughout the nation are interested. My recent articles on "Aerial Navigation" in *The Mathematics Teacher* and "Mathematics Problems in Aviation" in *High Points* have evoked a flood of inquiries from teachers as far distant as Massachusetts, South Dakota, North Carolina, California, New York and Washington.

There are two specific methods which can be employed by the teacher of mathematics in imparting information concerning planes and flying to high-school boys and girls. The first one, which is probably the more practical method for small schools, is that of introducing practical applications of mathematics in the solution of aviation and navigation problems in the regular academic mathematics classes. The second method is that of introducing special aviation courses in the high-school curriculum. A ground school course, including navigation, meteorology and civil air regulations, and a course in elementary aerial navigation would be extremely valuable in achieving the desired objective.

The aviation courses could be given either as extra-curricular

non-credit work or as special credit courses in practical mathematics. Personally I have discovered that it is immaterial whether or not credit is allowed for the work. The boys work as seriously and intensively in the extra-curricular courses as in the regular classes in aviation mathematics. When the objective is of immediate importance, credit motivation is entirely unnecessary. These pupils realize that they must enter the armed services of the country within a year or two, so they work like Trojans in courses which will increase their value and importance as fighting men.

A colonel in the Engineer Corps told me recently that the appalling lack of officer material among drafted men was due primarily to insufficient preparation in mathematics. He stated that the high-school graduate does not have a thorough groundwork of knowledge in this subject, so necessary in all types of military work. Mathematics is the basis of the technical and tactical training of personnel in the infantry and field artillery. Mathematics is involved in the coast artillery fire control and position finding systems used in pointing the guns of a battery for firing at a moving target. The operation of sound locators is based upon triangulation in geometry. Mathematics is involved in the preparation of aerial photographs as a basis for reconnaissance purposes.

The aircraft pilot must have a knowledge of aerodynamics, aircraft instruments, properties of airfoils, radio and navigation. The navigator must have a knowledge of the four methods of aerial navigation: contact flying, dead reckoning, radio and celestial navigation. He must know how to use a sextant. He must be familiar with the celestial sphere and spherical trigonometry. The bombardier must know the mathematics involved in bomb trajectories. He must know when to release his bomb, miles before he actually flies over the target. He must know the advantages of level flight bombing and dive bombing. If such problems are considered in high-school mathematics classes, the teacher of mathematics will experience no difficulty in obtaining maximum pupil participation and maximum pupil effort. A thorough foundation in mathematics will be laid. Furthermore, our army and navy leaders will have less difficulty in obtaining candidates for officer training.

I strongly recommend that large high schools make use of both methods of spreading information about flying and planes. All teachers can introduce practical applications of mathe-

matics in solving aviation problems in the various grades of mathematics. In addition, special courses in elementary navigation and ground school work in aviation are practical. This article is not a theoretical discussion of possibilities in disseminating aircraft knowledge. It is a report of actual experience in a small New York City high school.

I have used aviation problems in plane geometry and intermediate algebra classes with marked success. The topic of concurrent lines in geometry leads to a discussion of the position of the center of gravity in an airplane and the effect of a change in its position due to changing fuel or freight loads. The topic of similar triangles leads to a consideration of chart distances, marking off time intervals on an aeronautical chart for a contact flight, and solving an interception problem to determine the heading to be followed by a pursuit plane in intercepting an enemy bomber in the shortest possible time. The pilot of a bomber receives orders to leave Langley Field at 9.30 A.M. to intercept and convoy a steamer whose position is 120 miles east of Langley Field at 9.00 A.M. The steamer is traveling due south at 15 knots. The bomber's air speed is 125 miles per hour. There is a wind of 20 miles an hour from 225°. What heading should the pilot take to intercept the vessel as quickly as possible?

The derivation of the formula for the radius of action of an airplane is an interesting application of the solution of literal equations in the intermediate algebra class. Its derivation is based on the $T = D/R$ formula. The radius of action of a plane is the distance it can be flown out along a certain course and still have sufficient fuel for the return flight. How far can a pilot fly before returning to the starting point on three hours' fuel supply plus 25% reserve along a true course of 110° with a cruising speed of 93 miles per hour, wind from 245° at 20 miles an hour, variation 11° west and deviation 3° east?

The topic of positive and negative numbers in elementary algebra is motivated by its application to the navigation problems scheme, whereby westerly variation and deviation are considered to be positive and easterly variation and deviation are considered negative, when correcting the true course of a plane in order to obtain its compass course. Find the compass course of a plane if its true course is 36°, variation 6° east and deviation 4° west. Similarly, a right wind drift angle is positive and a left wind drift angle is negative in changing the compass

course to the compass heading, used by the pilot in flying the plane. What compass heading should be followed by a pilot flying a true course of 95°, if the variation is 10° west, deviation 5° east and the wind drift correction angle is 6° right?

The topic of vectors in the advanced algebra class leads to the use of the triangle of velocities in determining the ground speed of an aircraft, given its course, cruising speed and wind velocity. Find the ground speed and compass heading of a plane whose true course is 270°, variation 8° west, deviation 5° east, air speed 85 miles per hour, and wind 25 miles per hour from 300°. Or, during a flight check the ground speed and track, knowing that the compass heading is 82°, variation 11° east, deviation 3° east, air speed 98 miles per hour, and wind 20 miles per hour from 315°.

In the trigonometry class a discussion of the celestial sphere and astronomical triangle involves angle and arc measurements. Calculation of the azimuth and altitude intercept gives drill in the use of tables. Determining the great circle distance between New York and San Francisco or between San Diego and Darwin, Australia is a practical application of the use of trigonometric functions, logarithms and tabular interpolation. Pupils should be familar with latitude and longitude, Mercator charts and traverse flying.

With respect to the special courses in aviation mathematics, last term I conducted an extra-curricular course in aerial navigation, which was highly successful in awakening pupils to a realization of the importance of aircraft and flying in the world of to-day. The outline of this course appears in the article in *The Mathematics Teacher*[1] previously mentioned. This term I am giving a credit course in aviation mathematics, covering the work of a ground school course in navigation, meteorology and civil air regulations. My pupils can fly a Piper Cub by pilotage from Lock Haven, Pennsylvania to Rockaway Airport, New York. They can solve a dead reckoning problem: either before flight to change a true course into the compass heading to be followed during flight; or during flight, using their compass heading in order to check the actual track of the plane. They can use scale drawing to determine the direction and speed of the wind from two wind drift observations by solving the wind-star problem. They know that they must detour around an air-

[1] Lillian Moore, "Aerial Navigation," *The Mathematics Teacher* 35 (March, 1942), pp. 99–101.

space reservation indicated on a chart. They understand the influence of weather conditions, such as temperature, pressure, wind, humidity, precipitation, clouds and visibility, upon the flight of a plane. They know how to make the necessary corrections when using the aircraft flight instruments: the altimeter, air speed indicator and magnetic compass. They can determine their position by taking sextant observations of the sun and stars.

At the present time I am giving an in-service course in aerial navigation for New York City teachers. Fifty teachers are enrolled in the course. They come from all sections of the city and teach in all types of schools. All five boroughs are represented. There are registered vocational school teachers, elementary school principals, junior high school teachers, senior high school teachers of academic subjects, including mathematics, science, French and social studies. All are interested in learning about aircraft and flying, so that they can talk intelligently to their pupils about aviation. Model lessons have been presented on the historical development of flying, the control surfaces of an aircraft, the forces of lift, gravity, thrust and drag acting on a plane, stability of an aircraft, weather information necessary for safe flying, the operation and use of flight instruments, contact flying, basic problems of dead reckoning, special problems of dead reckoning, radio navigation, the use of the sextant, determining lines of position and fixes by means of celestial navigation. By following either one or both of the methods of increasing aviation knowledge suggested the alert teacher of mathematics will learn about aircraft and flying and teach his pupils to think about planes in the mathematics class before it is "too late."

A NEW CATALOG SUPPLEMENT

A new 16 page Catalog Supplement on Laboratory Glassware has just been announced by Corning Glass Works.

It introduces many new items and new lines—"Pyrex" Blood Bank Bottles, Lamp Sulfur Determination Apparatus with Fritted Disc, Distilling Receivers with Standard Taper Ground Joints, Bray Type Anaerobic Culture Dish, Lifetime Red Low Actinic Glassware (43 new items) and catalogs "Corning" Alkali Resistant (Boron-Free) Glassware for the first time.

All these new items are now available through regular laboratory supply dealers in the United States and Canada.

A copy of this new catalog supplement may be obtained by writing Laboratory and Pharamaceutical Division, Corning Glass Works, Corning, N. Y.

PHOTOGRAPHIC AIDS TO TEACHING

II. TRANSPARENCIES TO MOTIVATE BIOGRAPHICAL STUDIES

CHARLES TANZER, PH.D.
The Bronx High School of Science, Bronx, New York

In order to stimulate an interest in the lives and discoveries of great scientists, we have created a gallery of portraits inserted into the windows of our project room. The portraits were copied with the camera from halftone illustrations taken from several books on the history of science. The negatives were then printed by projection on Adlux paper (a product of the Defender

Company). This paper is composed of a heavy celluloid composition coated on both sides with the Velour Black emulsion. Printing and developing is precisely the same as with ordinary enlarging papers.

The completed portrait is translucent and is intended to be viewed by transmitted light. The pictures were mounted on translucent mimeograph paper and attached to the glass window panes. An additional pane of glass was then permanently mounted over each portrait in order to protect it from water and dust. The final arrangement may be seen in the accompanying photograph. Normal daylight illuminates the portraits and

passes through them into the room without any appreciable loss of light. The total cost of the project, which can be carried out by students having a limited knowledge of photographic technique, is about four dollars for three dozen portraits.

A DEMONSTRATION EXPERIMENT

INCREASE IN ELECTRICAL RESISTANCE WITH HEAT

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McBride High School, St. Louis, Missouri

The authors of most texts of high school and college level would rather leave it to the instructor's ingenuity to demonstrate the increase in electrical resistance in metals, both pure and alloyed. Just two techniques can be found to demonstrate this phenomenon. The first type demands that heat from an outside source, a gas flame for instance, be used. This technique, however, requires expensive and cumbersome equipment. The second type, in which the heat generated by the current itself may be used, eliminates much of the auxiliary equipment.

The experiment here described is of the second type, and is submitted for these advantages:

a. Rapidity of assembly, requiring only connections of the unit to an ammeter and a supply line.

b. Time of demonstration for each metal is not over two minutes.

c. Only inexpensive and commercially available materials are used. The total cost is under two dollars.

d. Convenience of being operated on 110 volt supply, either D.C. or A.C. and at any frequency.

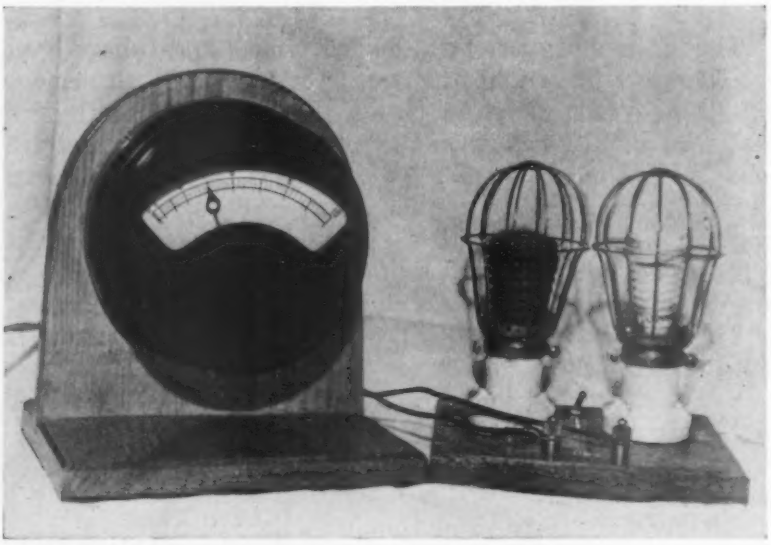
e. Safety, to be wholly fool-proof and accident-proof.

f. Visibility to a large class will depend on the availability of a large scale ammeter (5–6 inch scale).

The heart of the equipment is two 600 watt nichrome heater coils, screw base type. One coil is kept intact. From the other coil form the nichrome wire is stripped. In its place is put a coil of iron wire. It was found that of the iron wire which our laboratory used in tensile strength experiments, the #27 was right, and about thirty-five feet of that. This wire is wound into a helical coil on a $\frac{7}{32}$ inch rod, and distributed into the grooves of the porcelain cone to replace the nichrome. Experimentally

the coil was shortened so that the ammeter gave nearly full scale deflection on cold contact, but did not go off the readable scale at the lower end either.

The coils themselves are mounted in the standard porcelain sockets. Over each coil and attached to the sockets the lamp guards were mounted to prevent accidental burns. A great help to the ease of manipulation is the single pole double throw switch with an off-center position which is connected into the circuit. This allows complete control. The switch is mounted behind the coils for the instructor's convenience.



The cold resistance (ohmmeter measurement) of the iron wire is about 9.3 ohms; the nichrome gives 19 ohms in the cold. For reference, both these numbers are marked in white enamel on the base.

If these numbers are given to a class to calculate the expected current, beginning with the nichrome coil, the observed and the calculated currents will not be too divergent. But when the pure iron wire coil at cold contact draws only 9 amperes, and within two seconds shows an ammeter reading below 5 amperes, the result is, to say the least, arresting. It can be shown to any class of even moderate ability that, neglecting the inductive effect on an A.C. supply, the nichrome from cold to hot varies only two ohms in resistance, while the iron wire changes from

approximately ten to fifty ohms. The tabular form gives approximate results.

Among the major factors in pupil appreciation of a demonstration experiment are the ease of comprehension and visibility. The former is obtained by keeping the experiment out of the quantitative class. This experiment was never meant to be such. The latter factor is obtained by the large scale ammeter, easily readable from every seat in the lecture room. The author's solution for good visibility lay in a second hand A.C. panel-type meter (0–10 amperes) mounted on a portable wooden stand.

The only known disadvantage is the inability to repeat the experiment immediately, as the time for cooling the coils to room temperature is at least five minutes. Where identical results are not expected, the experiment can be repeated immediately, and any number of times.

Time	Nichrome	Iron
0 sec.	6.5 amp.	9.0 amp.
2	5.6	5.0
4	5.5	4.5
6	5.4	4.0
8	5.3	3.5
10	5.25	3.0
1 min.	5.25	2.7
2	5.25	2 5

MATERIALS

Hardwood base, about 7×8 inches
Pair of binding posts
Switch, S.P.D.T.—off-center, 3 amp.
Two porcelain cleat sockets
Two 600 w. heater coils, cone type, screw base
Two lamp guards
Iron wire, #27, about 35 feet.

EDUCATION CAN HELP TO WIN THE WAR

The schools, colleges, libraries, and other organized educational institutions of America are making and can continue to make substantial contributions to the winning of the war. Without these contributions the outlook for victory would be considerably darkened or delayed. If, as now seems unlikely, the war should end soon, we shall be plunged abruptly into problems of postwar reconstruction requiring all the wisdom of an educated people as the only alternative to chaos or dictatorship. If the war lasts several years, the contributions of education will be all the more desperately needed.

EDUCATIONAL POLICIES COMMISSION

NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago

(Continued from the October issue)

26. The Layman's Use of the Word Proportion. In an earlier paragraph (item 4, Feb. 1942) I mentioned how a pupil's concept of proportions can be improved by having him collect examples of them from books, newspapers and magazines. Many examples were found in which the word was not used as a mathematician uses it.

For example, Shaw in his introduction to *Pygmalion* writes, "The colossal proportions of the cinema industry make mediocrity compulsory." Here proportion means size.

Pearl Buck in *Dragon Seed* writes "Sun and rain were in proportion." This may be justified as poetic license.

A pamphlet on labor relations states that an increasing proportion of all private production goes to salaried workers. Here proportion means *part of*.

Being curious to learn what ideas other people associated with the word, I submitted a sentence using it to friends and asked them to state what the word meant. The sentence was:

If you drive your car at a fixed speed then the distance you go is proportional to the time spent driving.

I asked teachers, lawyers, bridge players, musicians, and salesmen (not engineers, nor teachers of mathematics or science). Typical answers were:

The distance depends on the speed.

One is in relation to the other.

The hours influence the distance.

It is an idiomatic expression showing relationship.

One has a direct bearing on the other.

It takes time to get anywhere.

You should divide the distance by the speed.

The word is used wrong because no ratios are stated.

With the possible exception of the last two answers none of these people thought quantitatively. To see if I could arouse any sense of numbers in the reader's mind I next added the following instructions:

My object is to learn what you think of when you read the word *proportional*. Which, if any, of the following ideas occurred to you or might be a suitable explanation:

1. The distance is a certain number times the time.

2. You thought of two possible distances that you had at some time driven, and of the hours it took to drive those distances. If so,

(a) did you compare those distances by dividing one distance by the other, and did you divide one time by the other time?

(b) or, did you divide one distance by the time it took and compare that result with the other distance divided by its time?

3. You thought that if you double the distance you wish to go you must double the time, or if you triple the time then you can drive three times as far.

This time I limited myself to engineers, accountants, economists and to those whose training or work involved some use of mathematics. The answers were about evenly divided between 1 and 3; no one said that the relations in 2(a) or 2(b) were first in their minds.

27. How Bright Are Economists? My curiosity about proportions was further aroused when I read an article in the *Survey Graphic* (Jan. 1942) by one of the leading economists for the National Labor Relations Board who wrote:

"It seems to be very difficult for people to grasp the fact that an increase in wages does not mean a proportionate increase in total costs. If labor represents 20% of the cost of operations, and if wages go up 50%, total costs go up 10%. . . . In other words, a 10% increase in wages does not mean a 10% increase in costs."

Let us consider the following figures:

Labor costs	Other costs	Total cost	% increase in labor costs	% increase in total cost
20	80	100		
30	80	110	50	10
40	80	120	100	20
50	80	130	150	30

It seems that the numbers in column 4 are proportional to the numbers in column 5; hence the per cent increase in total cost is proportional to the per cent increase in labor costs. Evidently what this economist meant was that the numbers in column 4 are not the same as those in column 5. That much is true. And we might add:

"It seems to be very difficult for some economists to use the word proportionate as mathematicians use it."

And we might add further that this economist was misleading the public. He emphasizes the fact that the numbers in column 5 are smaller than the corresponding numbers in column 4, and he implies that because they are smaller we need not worry about them. But if a five dollar article increases 50 cents in cost, I should not be fooled by the fact that the increase is only 10% and the number 10 is smaller than the number 50. We do not pay our bills with per cents; we pay them with cents.

28. What Should We Teach about Proportions? If the variables are denoted by d and t, and if d is proportional to t, there are four relations to consider:

1. $d = kt$
2. (a) $y_2/y_1 = x_2/x_1$
   (b) $y_2/x_2 = y_1/x_1$
3. If $x_2 = nx_1$ then $y_2 = ny_1$; that is if x is multiplied by n, then the new y is n times the former y.

In the questionnaire to my friends I had tried to learn which of these four ways would occur to them. The mathematically untrained did not think of these relations at all; the mathematically trained thought first of relations 1 or 3.

Relation 1 is found in some textbooks and is usually presented as a principle:

If the variables y and x are proportional then the relation is always of the form $y = kx$, and

If $y = kx$ then y is proportional to x.

Relation 2(a) is the one which is emphasized by similar figures in geometry, and y_2/y_1 is the ratio of similitude.

Relation 2(a) or 2(b) is used in general mathematics and in elementary algebra for such problems as

A picture is $2\frac{1}{2}$ in. by $4\frac{1}{4}$ in. If the picture is enlarged so that it will be 10 in. wide, how long will it be?

Relation (3) seems to be the most neglected one; it gets very little attention in any course.

Ever since Judd made his famous speech on Informational Mathematics versus Computational Mathematics (see the *Mathematics Teacher*, April, 1929) teachers have been growing more conscious of the fact that elementary mathematics really embraces two parts: the computational part which a worker must have at his finger tips, so to say, and the part which requires a knowledge of mathematical concepts rather than computational ability. Relation 3 belongs in this field and more emphasis should be put on it and similar relations. The citizen

who seldom does the computing involved in 2(a) or 2(b) should be familiar with relation 3 to understand his newspapers and magazines.

29. Suggestions for a New Approach. The present practice, to judge from textbooks, is to begin the work on proportions with problems which lead to equations like $x/32=3/8$. Many of these problems can be solved by elementary arithmetic but they are needed to introduce the vocabulary. The pupil learns that equations of this type are called proportions and that the product of the means equals the product of the extremes. These ideas are applied to similar figures; if time permits, quantities that are inversely proportional or proportional to the squares are next considered.

Someone should experiment with the possibility of reversing the order mentioned above. A unit on dependence could be introduced in the middle of the year. Begin by making tables of values and graphs for many types of equations. In certain of these tables we notice that $y_1/y_2=x_1/x_2$, and these variables we call proportional. In some tables we see that $y_1/y_2=x_2/x_1$ and these we call inversely proportional. In some tables $y_1/y_2=x_1^2/x_2^2$ and we say that y is proportional to the square of x. For each case we can study what happens to y when x is replaced by nx. The pupil should get the habit of associating the word proportion with the words multiplication and division.

After this work on relations has been completed we can attack those problems which are now being used to introduce the subject. The new approach would not make the study of these problems any more difficult and may help to leave a more lasting understanding of proportions with those pupils who need information about mathematics rather than computational ability.

Some one should also investigate why some statements about proportions are easier than others for the layman to understand. I found that most people could give good (though not mathematical) explanations of such statements as:

In proportion to their numbers more colored than white cadets passed their first test.

The number of people at the beaches is always proportional to the day's temperature.

Teaching, today, is war work.—*Paul V. McNutt, Chairman, War Manpower Commission.*

OUR NEGLECTED SYSTEM OF NOTATION

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Our students in high school and college do not know the basic facts concerning the Hindu-Arabic notation. For some years the writer has made it a point to ask every incoming class of college freshmen: "How many thousands are there in a million? How many thousands in a billion?" The correct answers have never been forthcoming from more than half of the class and very often from a much smaller fraction than that. Why such ignorance? Could there be a topic of greater "social utility" in present-day mathematics than numbers of astronomical dimensions, figures that march across the page in ranks ten or more deep, and long queues of ciphers that follow a lonely leader in tedious Indian file? What is, for example, the place value of each digit in the latest number set for the National Debt Limit? Or can you quickly figure in your head what the per capita cost of the war will be according to Federal appropriations made to date? We are in a chronic state of "billionitis," as some jester has put it; and we shall never get out of it because we are a people numbering over one eighth of a billion souls. The collective finances of such a gigantic nation must inevitably run into billions. It is only a truism to say that, if these finances are to be properly managed, the people must know the mathematical facts pertaining to such enormous numbers; they must be at home among billions as they have always been in the range of their individual pocketbooks. Numeration, which was formerly a big topic in arithmetical instruction, has once more become a subject of importance. Education for good citizenship now includes a functional understanding of the Hindu-Arabic system of notation.

In the present curricular setup a systematic study of mathematical notation is most likely to fall through, swallowed up in the gap between arithmetic and algebra. In grade-school arithmetic the subject of notation is probably deemed too theoretical, and for high school algebra it will be regarded by many as too specifically arithmetical. So where is a pupil going to get it? It would make an ideal topic for that course in ninth-year mathematics we have talked much about in recent years.[1] I should like to suggest, however, that it can be beautifully fitted into the traditional courses in elementary and intermediate algebra,

[1] Cf. *The Mathematics Teacher*, 1941, XXXIV, 7, p. 309 ff.

as a sort of irrigation canal that may easily turn semi-arid stretches of that subject into verdant pastures.

Since "God made the integers" while "the rest is the work of man," as we were informed by a mathematician of renown,[2] we might just as well begin this topic, like so many others, with whole numbers. Now, a whole number of several figures, represented in Hindu-Arabic notation, is really a marvel of conciseness. With the aid of the principle of position such a number implies, condenses, and abbreviates the three direct fundamental operations of addition, multiplication, and involution. The idea of notation, achieving a prodigious triumph for the method of concentrated symbolism, is thus seen to set the stage for all mathematics. Watch your neighborhood grocer total up the bill: He is performing some of the shrewdest tricks of mathematical shorthand and—is quite unaware of doing them. He takes a group of monomials, binomials, trinomials, or even higher polynomials, which have all been arranged for him according to "descending powers of the number base or radix 10"; he "commutes" and "reassociates" the terms to be added, unwittingly applying the commutative and associative laws of addition. With an astute regard for the different powers of the radix, he collects similar terms and "carries" certain coefficients from one power to the next higher one, always using the distributive property of multiplication, of which he has never heard in his life; and he puts down his result, again, as a beautifully ordered polynomial, all neatly arranged with the correct coefficients (we hope) from the zero power of 10 to whatever may be the highest power involved in his particular result. But don't you ever ask him a theoretical question about his figuring, or—what would be still worse—don't mention any of the mathematical terms just enumerated to him: As likely as not, he will report you to the nearest copper as a propagandist for some new subversive "ism." What a work of genius our notation must be when it can be used so blithely by the ignorant! Alas, as so often, the invention of genius has become a common tool to be treated by the mass with the contempt that is born of familiarity.

Let no one think that this exclamation purports to reflect on the state of erudition among grocers. It is merely a reminder to the teachers of mathematics that there is a rich field for the application of algebra, which they are neglecting, if in their

[2] Leopold Kronecker, quoted Tobias Dantzig, *Number, The Language of Science* (NewYork, 1930), p. 99.

classes they do not talk—nay, rave, grow rhapsodic, and sing paeans of praise—about our wondrous system of notation, the greatest single service that the Orient has rendered to the Western world.

What I should like to propose is simply this: That the part of the course in beginning algebra which is pompously called "operations with polynomials" be prefaced by, or accompanied with, a discussion of notation so that the essential continuity of arithmetical and algebraic procedures may become evident to the student. "Polynomial" is a euphonious name; but how many high school students of algebra will meet and recognize the "critter" in their future lives, once they have turned their backs on the exotic zoo of the mathematics classroom? Let us, therefore, tell our pupils that a polynomial is not a rare animal at all; that it is with us in every multi-digit number symbolized in Arabic numerals; that, by way of illustration, the number 7,654,321 is a high-powered polynomial in 10, namely:

$$7\times10^6+6\times10^5+5\times10^4+4\times10^3+3\times10^2+2\times10^1+1\times10^0.$$

In consequence, many algebraic rules and manipulations have their prototypes in arithmetic and can be blandly presented to the beginner in algebra as old acquaintances. Take parentheses. In presenting the idea of parentheses we should make use of the analogy with arithmetic. Every number of more than one digit is girded and guarded by an invisible armor of parentheses, and we remove them in algebra exactly as we have been wont to do in arithmetic. When we subtract a two-digit number, for example, we assume the subtrahend to be in parentheses and take away each digit individually; when we have a two-digit multiplier, we "distribute" the multiplicand between the two digits of the multiplier, since multiplication is distributive with respect to addition. Again, the concept of the single algebraic term, or monomial, which may consist of more than one letter or number provided these are neither added nor subtracted, is reflected in the double value which every digit has by virtue of its position, namely, intrinsic and place value. Each digit in the number given above represents a monomial composed of an expressed coefficient and an unexpressed, implied power of 10. From this idea it is but a step to that rule, which might seem arbitrary to a novice in algebra: Multiplications and divisions shall be performed before any additions or subtractions. There is nothing in this rule to mystify him who knows that every digit in our notation is like a tightly wrapped package of so

many times a certain power of 10, and before these packages can be added together, they must first be made by means of multiplication and involution. Nor should there be much ado about dressing up some polynomials for the ordeal of long division by arranging terms; for in arithmetic, too, the terms of dividend and divisor must be in a fixed order; fortunately, it was the ingenious Hindu mathematicians who have done all the arranging for us "according to the descending powers of the common letter 10" many hundred years ago. Finally, the collecting of similar terms by adding and subtracting coefficients, that, too, is but an old stunt which we have practiced ever since we started adding figures in more than one column.

If arithmetic is used to fertilize the acres of algebra, algebra can be expected to repay arithmetic from the fruits of its own harvest. There comes a time for this return service in the chapter on powers. We need the powers above the cube to drill the laws of exponents, although such powers of a letter are seldom encountered in walks of life not strictly mathematical. Why should we not use the powers of 10 to do our multiplications and divisions with and kill two birds with one stone: teach the laws of exponents and prepare the way for that very practical subject of scientific notation, which in turn is a springboard for the study of logarithms? Billions are not likely to be confused with millions—you can hear noted ratio commentators do it—if they are registered in the mind with their proper exponents, and the mental juggling of astronomical figures, now the patriotic preoccupation of every thinking citizen, should be a much more precise art if carried on with the aid of exponential notation.

The usefulness of teaching the principles of notation is not limited to the course in beginning algebra. When zero and negative integers are introduced as possible exponents, reference to decimal fractions will bring the subject down to an everyday level of intelligibility. All that need be said is that each digit to the right of another digit represents a power of 10, one less than the preceding one. The exponent of the tens' digit is 1; next to the right come units and the implied exponent should be $1-1$, that is, zero. The first place after the decimal point has the exponent $0-1$, which is -1, and so forth. Here we have an opportunity to tie up the somewhat startling notion of negative exponents with something already familiar in the grades.

What is probably the most interesting reference to notation should be made in the chapter on progressions. The benefits

of positional notation are much extolled, but we rarely hear about another aspect which ought to be called, it seems to me, the social menace of the Hindu-Arabic notation. This menace is easily pointed out: The ascending powers of 10, which make the place values of the digits, form the members of a geometric progression, but the number of places, as symbolized from right to left, form an arithmetic progression with a common difference of 1. As a result of this fact, the large numbers are deceptive to the eye. The law of growth suggested by setting figures side by side in symbolizing numbers is additive, but the law of growth underlying the place value of these figures is multiplicative. You add one cipher and thereby multiply the value by 10; you add two ciphers and thereby multiply the value by 100, and so forth. This is, of course, nothing new; but the writer believes that the confusion between the two laws of increase is a very real thing in the minds of numerous Americans today. Large numbers, such as millions and billions, do not appear to the reader as gigantic as they really are. An innocent cipher—to most people, after all, a symbol for nothing—when added to a billion dollars makes a difference of no less than nine billion dollars. The same cipher added to ten dollars makes a difference of only ninety dollars. It is very likely that most people form their intuitive opinions about large numbers from the experiences they have had with sums within the range of their individual pocketbooks. A transfer of these quantitative conceptions to higher place values must lead to the most dangerous illusions, to collective misjudgments which, under the regime of the older notations, were not likely to occur. In earlier days large numbers were seldom written[3] because of little practical use for them; but when they were, new symbols had to be designed for the higher powers of the number base, and these symbols, by their mere novelty and rareness, commanded all due respect. There is also something to be said for the overly conservative method, practiced by the Chancellors of the Exchequer of Great Britain until the beginning of the nineteenth century,[4] of keeping national accounts on wooden tally-sticks, the different multiples of 10 being indicated by notches of appropriate sizes. If the notch for 1000 pound sterling was "the thickness of a man's hand,"[5] of what awe-inspiring dimensions would have to be the notch

[3] Cf. D. E. Smith, *History of Mathematics* (New York, 1926), Vol. II, p. 36 ff., in particular pp. 60, 80, 87.

[4] Tobias Dantzig, *Number The Language of Science*, p. 23.

[5] *Encyclopedia Britannica*, 14th Edition, Vol. 21, p. 768.

for a billion? It is the one unfortunate feature of positional notation that it may breed contempt for large numbers, simply because they can be written so easily by the mere repetition of the ten basic numerals. Let us, therefore, as teachers of mathematics be aware of our obligation to society and create in our pupils' minds a functional understanding of number notation.

EDUCATIONAL TRAINING FOR MENTAL CONDITION THROUGH CAMP EXPERIENCE

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Education is a training to prepare us to best live the life we have before us. It does not always come from the acquisition of the best thoughts of the greatest thinkers of the past, as I well learned when I first saw poorly prepared instructors teaching others less well informed in the first flying school after the invention of the airplane.

For years I have been telling a story that illustrates my conception of what constitutes an educated person. It is not original but it presents an original ideal of true education.

Once upon a time there was a certain college professor who was so busy perfecting the training of his mind, in securing additional knowledge, and making extended research that he overtaxed his physical ability and was ordered by his physician to take an extended recreation-rest period in the woods of Northern Canada. He was located on a very large lake, had a competent Indian guide, and found the fishing there to be enjoyable; but like most of us, he was not contented to remain on his side of the lake. The other side could be dimly seen on the horizon and to him conjured up visions of greater and greener fish pastures.

The Indian guide always replied to his requests to cross: "Lake too big. Storms bad. Canoe too small. No better try." But one fine day was finally persuaded to make the crossing.

The professor, to relieve the monotony of hours of paddling, endeavored to engage the taciturn Indian in conversation. "I don't see how a person can really live in this wilderness in ignorance of what is going on in this world; but then, I suppose you have books and papers to read during the long winter evenings."

"Me no know how to read," replied the guide.

"My! My! I cannot conceive how you do exist in such ignorance, but then I suppose you have a radio and can get the news and learn what is going on in other places," added the teacher as he noted the increasing severity of a sudden summer squall and the white capped waves around the frail canoe.

"No have radio. No battery, no juice up here for me," replied the Indian more worried by local than world conditions.

"I don't see how you can live in such abysmal ignorance. I know I could not," was the complacent reply.

Just before the storm grew to the violence that swamped the canoe in the middle of the vast lake, the guide asked, "You know how to swim?"

"Why no. I never went in for physical education. Sound mind in sound body is all that matters. I have never found it a necessity to learn to swim," replied the teacher.

"Me know damn well you not live much longer in 'bismal ignorance," muttered the guide as the storm overturned the canoe.

In all sincerity I ask you, "Which man was the educated person in the above emergency?" Education of today must fit man for mastery of the earth, air and water. He escapes from contact with many of the perils of his prehistoric ancestors but he must face many more deadly ones his ancestors never worried about. In school a passing grade is not always "A" but in the fast moving mechanical life afterwards a "B, C, or D" puts a man in a hospital or grave.

Let us briefly outline the pathway down which man has been traveling for the past million years; what he gained, what he lost and how he has forged ahead. How man-killers have changed from fierce beasts to fellow men and why, in this thing called war, the fiercest man-killers will be on the winning side, other things being equal.

When the animal man left the protection of the trees for ground life he was a slim, nervous, grey-hound type of individual alert to all the dangers about him and depending upon agility and quickness of flight to escape from sudden death.

When he learned to grasp and use a club or staff-like spear, he changed to a brawny, resolute bull-dog type, who united with fellow men to bravely stand his ground and fight off dangers.

Long periods of survival of the fittest, bred types true to the

form best adapted to survive but left instinctive behavior traits. Then came the projection of missils; stones from slings, arrows from bows, bullets from guns, which taught caution and co-operation of groups, and increased the desire to kill fellow men by the ease with which it could be accomplished. It brought about long periods of training for the skills necessary to success. Agility of flight and resolute fortitude were relegated to the background of traits by predatory aggressiveness.

Early in this process man got his sixth cervical vertebra straightened, his brains truly atop his backbone, lifted his chin and looked with eyes forward, although in the last few hundred years modern education, with tables and flat topped desks, has endeavored to induce the child to again resume Neanderthal or gorilla posture and by so doing often demands a sacrifice of natural eyesight to gain an education. It is a debatable point whether primitive man did not use his eyes more in reading than the average working man of today. He read tracks and movements, located food and foes, and was early eliminated from the prospect of being an ancestor of hardy men if he was a dunce or a dolt in so reading the signs about him. The early youth faced the saber-toothed tiger and cave bear as the American youth must face the enemy machine-gunner.

This is an appeal to include in our school curriculum the kind of *resourceful adaptability* we should teach our youth, a revival of the mental alertness, physical stamina, and Yankee inventiveness that *our* pioneer ancestors brought to America. It enabled them to survive and succeed in overcoming wilderness obstacles while other individuals with less resourceful adaptability perished without leaving numerous kin for welfare agencies and government aid in the later generations.

Our present physical education programs, good as far as they go, lay too much stress on team work for a selected few top notchers in ball games and the like and not enough on hiking, marching, camping and woodcraft for the whole group. Even the school bus is helping to eliminate walking to school. Babe Ruth and Lou Gehrig are emulated more than Boone, Washington or Lincoln in the physical education. Each generation is losing more and more of the instinctive ingenuity and inventive resourcefulness necessary in time of adversity to the individual. I wonder if the homemaking teachers in the public schools could successfully pass such an examination as this: A gnawing hunger in the wilderness, one live fowl, an open fire, a little flour and

some wild berries. Have we lost other instincts besides that of swimming?

One article or address will not teach the fundamentals of campcraft and wood craft. Like navigation and social studies they must be mastered, task by task and lesson by lesson. There are books enough written on the subject, but I doubt you will find many good ones on your library shelves. Librarians relegate these to the same place my mother once put my Buffalo Bill, Diamond Dick and Nick Carter literature. The *Boy* and *Girl Scout Handbooks* are primers of open air life and should be found in all school libraries. Nessmuck's *Woodcraft* is one of the best small volumes. The author lived up to ideals of traveling light, with a lot in your head and little on your back, when he wrote it. The Cornell *Leaflets on Outdoor Living* which Prof. E. Lawrence Palmer has published have put much necessary and vital knowledge in the hands of grade teachers of New York State. We hope that some day the curriculum will permit the use of this information.

Booklearning without actual trials and experiences is worthless in any field unless the reader is a gifted individual able to vicariously live the information read about; be it adventure, campcraft or love. Such reading does afford diversional recreation and builds up the desire for experiences read about.

It is my belief that we have always needed, and must now emphasize, the best training to fit the mental outlook of the individual to best face the sudden calamities of life in a calm, resourceful, purposeful manner. Such adversity might be a school fire, an air raid, a sinking ship, a flood, an auto crash, lost in the woods, or food scarcity and guerrilla activities against an invading enemy.

We educators train in a few essentials, like drills for fires and air raids, but argue against further instruction in individual resourcefulness. We commend camp life for the few selected individuals, known as scouts, but not as an essential integration in the educational program for all children. Too many of us complacently believe that the mental training for the individual resourcefulness can be vicariously learned.

Unregimented but disciplined camp life can replace many undesirable behavior traits and mental characteristics with valuable instincts that were once man's heritage. Fear without panic is a valuable asset but reckless risking dangers in needless bravado is one of nature's methods of early erasing the moronic

unfit from its creative plans. A period of Camp Life for each child can develop and repress instincts that will be of lifelong value to the individual.

Pam Hollingsworth is an example of what a lost person can endure if she escapes panic. She was the little girl lost for a week in a great state park. The most veteran rangers, judging her by adult standards, knew she must have perished as she was thinly clad and nights were freezing cold. While they searched for her body she came out under her own power, hungry and worried because she had lost her pretty hair ribbon.

She was too young to have learned or developed those civilized instinctive traits that are fatal to adults. She just walked, drank from brooks, probably cried a lot but when night came she found a protected nook or crevice to crawl into for sleep like a healthy animal would do. She did not rush blindly about to fall in brooks, trip over logs and stones, lie exhausted on the ground until strength came for more panic-stricken rushing until merciful death or searching friends came to stop the demented actions of the lost one. The forest rangers knew that American civilization, while doing some of the most wonderful things, has caused a deterioration of the pioneer instincts which were the heritage of Washington, Boone, Lincoln and Carson.

In the New York State Parks the rangers, wardens, troopers and hunters spend thousands of man-days in looking for lost people. These parks would seem like back yards to the pioneer group that won and settled this great country. Why do people lose their personal confidence when surrounded by trees, smoke or open water? The best of guides and hunters lose their way and camp at times, just as the motorist takes the wrong road or the pedestrian the wrong street; and it is no more serious because they do not let the darkness of insane blind panic shut down upon their mind and place them in a lower scale of intelligence than a beast.

School camps will never deal with abstract "What to do when lost" problems but strive to build up the philosophy of the lost Indian who said, "No. I'm not lost. I am right here with myself. The camp is temporarily misplaced to me."

Few who have not dealt with fear crazed peoples can realize the harm done by groups of European peasants and how it can spread even to the trained armed forces in a Nazi-blitzkrieg. Western Europe had an educational system in many ways similar to our own and like us disdained the more recent virile

Russian form. I believe that the mental conditioning through training contrasted the difference between fear crazed Western European peoples who clogged the highways and hampered military movements and the resolute, resourceful fortitude of Russians who applied the scorched earth policy and gave aid to their armed forces.

My first experience with a fear crazed lost man was in the Tug Hill Plateau west of the Adirondacks. On a warm, dry day a lost deer hunter came splashing across a brook chanting, "whereami, whereami, whereami?" His face was streaked with blood and dirt and Eddie Cantor was a squint eye in comparison with his expression. We fed him and damned him, gave him half a loaf of bread, some matches, a little advice and a lot of cussing and sent him to his camp. Next day we went over for a visit. The hunting party was as nice a group of young men as could be found on any college campus. The only way we could identify our lost pilgrim was by briar scratches on his face. In the big woods he could easily have chased himself to his death and the better his athletic training and condition the more prolonged would have been the terrors and tortures he would have inflicted upon himself before that death.

While returning from a deer hunting trip I sat in an Adirondack hotel at lunch and overheard the discussion of a trooper and warden at the next table describing one of these problem wild men. The trooper said, "There was snow on the ground and the fool could have backtracked to camp. He had been out all one day and night. We tracked him in the snow but he kept running away from us. Had to run him down, handcuff and pistol whip him and then carry him in. He fought us all the way—that is while he was conscious."

When I returned home I was surprised to find the lad was a star athlete in one of my high schools. I have looked over this quiet mannered youth and wondered just what hidden alchemy suddenly changed him to a beast of low mentality unable to know his own tracks led from the camp he had lost. He snapped out of his insanity when back in familiar circles but how many such potential menaces are our schools educating each year?

How many extra months of military training will it take to make potential soldiers of such nice, athletic boys? What if that blind panic comes in a cockpit in fog, storm, or the blackness of night? We have got to add something to the tough commando training to insure our school boys running in the right direction

when they face a foe. Universal Scout training for boys from 9 to 14 years of age can build this foundation.

Nathan Graves was a boy of unusual intelligence and talent whose progress I had watched from the first grade to graduation. As a poet and artist he drew the portrait pictures of his principal and class advisor in the school yearbook. A fortnight after graduation from high school he went wading and stepped into a deep hole over his head. He died. Twelve years of education to a most promising youth washed away ten days afterwards because in that time his educational training had not included resourceful fortitude and presence of mind to turn about and, like a wombat, crawl out along the bottom where he waded. He may have drowned from lack of knowing how to swim or from a "shell shocked heart" due to his panic as the medical authority said. It matters not now.

We do not have to surrender to civilization the right to rob the individual of resourceful fortitude in the regimentation of co-operative actions and activities. For a score of centuries the Mediterranean peoples had or copied the culture of Greece and Rome and enjoyed their grand stand athletics while the rest of Europe was peopled by skin clad barbarians. I think we agree that the descendants of these barbarians are a more emotionally stable group of countries but still we pattern our athletics after the cultures of the Mediterranean peoples.

Sitting in a grandstand cheering chariot races or horse races, marathon races or football, gladiators or prize-fighters, bull fighters or basketball does not give the individual the exercise, physical stability or mental conditioning he needs. "Grandstanditis" has swept America into the slimy tentacles of letting George play ball while we cheer and boo the results. America is taking its exercise in wearing out the seats of pants on grandstand benches instead of shoe leather in hikes for all. The Boy and Girl Scouts are group movements away from the entertaining type of exercise, coached and specially trained to almost professional standards. I believe the camping, hiking and scouting program should be the heritage of all our youth and not given only to select groups who have the time, the resources, or the fortunate environment to receive this training. The school under trained professional leadership is the unit best fitted to take over and unite the volunteer leadership now being given in larger centers to a portion of our youth.

I am not condemning present athletics but advocating an en-

riched curriculum to include camping and the study of nature. Grandstand games, like the orchestra, band, amateur theatricals still have a place as amusement for the group and hard work and the display of skill for the few participating.

Should the camping program include Military Training? Camp life, ability to look after comfort and health, and make the most of the few essentials at hand should come first, then the military training, if possible. One of the best arguments I could give for a school camp program is that it might teach future officers more respect for mud and mosquitoes in laying out camps. If all the work later expended around C.C.C. camps to put in gravel had been used for emergency landing fields instead of keeping the boys out of the valley mud, we would have another military asset today.

A few years ago I was camped near the village of Number Four N. Y. while wardens, troopers and rangers were looking for a lost hunter near the camp. The local ranger told an amusing incident about the lost man when he was rescued. He was a husky, intelligent young fellow who did not go into a panic or start running. As he sat on a log, wolfing sandwiches and drinking hot coffee from a thermos bottle, the ranger asked him what caused the bulge in the back of his hunting coat. The man put his hand in the pocket, a peculiar look came over his face as he exclaimed, "That's my lunch I took out yesterday morning. I've been too busy to eat it." Warden Boyd tells even a better story of the lost hunter he found running down a trail clad only in white undershirt. The man got so hot he threw away his clothing. Fortunately he was running away from his camp, so as they retraced their steps the man was both clothed and in his right mind when they reached camp.

There is no point to mention the tragedies that occur in the woods as this is a plea to bring back into American education some of the best parts of the declining or lost heritage our pioneer forefathers learned from the Indians and daily experiences. For instance the pioneer youth recognized the gun and axe as essential tools and used them efficiently. He never pointed a gun at a human being or dog he was not willing to kill if necessary, but today boys who would never dream of chopping down the trees that line our city street, have forgotten the purpose of a gun and eagerly point one at a companion, a dog, or set up targets oblivious of whatever lies beyond. The crying need from our educated youth is more attention to the inventive

resourcefulness and common sense self confidence that will stand by in the army, the navy or the factory. American youth probably possesses these qualities to a greater extent than those of other lands farther removed from the wide open spaces and opportunities for camping. We have quite a task to change hitch hiking to a real love for foot hiking.

We need this universal scout training for the most important business this country will have for the next few years. Camping on the curriculum might be like Latin. Everyone might not use it after school days are over.

I have camped near Ithaca in extreme summer heat and at Sunday Creek when it was 20 degrees below zero. I used the same tent but different types of beds and stoves. I do not like the extremes of weather but in both cases the tent camp was comfortable and incidental to the business or pleasure at hand. While attending Cornell University, my wife, a small child and I slept under woolen blankets while summer school students complained they could not sleep because of the excessive heat in dormitories. One group who camped was poorly equipped with excess impediments of camp nature and lack of training and left ill as the result. A minister, his wife and child pitched camp in an open place where mid-day sun melted all candles in the tent. They gave up the idea of camping soon afterwards. You cannot even pray God to be on your side and protect you from all harm if you neglect to know the laws of nature and to do your own part.

My fellow campers sought only the formal knowledge to be gained at the university but I also got passing grades, enjoyed fishing and swimming each day and I know my wife enjoyed the simplified housework and came home with more appreciation for a modern kitchen and bath tub.

I have endeavored to show that present day America is gradually drifting away from a vital mental quality, best remedied at present by the Cubs, Boy Scout and Girl Scout movements. Inventive resourcefulness is an antique, discarded and not yet recognized for its real value. Scout movements are good except they are taught to selected groups, most often by volunteer and, in many cases, untrained leaders. We could do a better job in the future by universal training under well trained leaders in school supported camps. Both rural and urban children could truly sing with more understanding, "I love thy rocks and rills, Thy woods and templed hills, My heart with rapture thrills . . . ."

I would like to outline a course of instruction for living in adverse circumstances,—something like a first aid kit which all hope never to use,—where food would be what you could get, clothing what you have and shelter what you could utilize from materials at hand. Like the first aid kit we probably would dip into this information from time to time in an emergency, but after all it would be of no more interest or use to the average student then Greek and Latin. Moreover in this age of specialization in instruction it would require the resurrection of that extinct species of man known as a hobo for a teacher. The growing tendency upon which our young Americans are leaning more and more is for Uncle Sam to provide (but he leaves no provisions in his will if he dies) for welfare, W.P.A., P.W.A. and N.Y.A. so they will not need to know about the inventive resourcefulness and hardy fortitude that first made the good old U.S.A.

ADULT EDUCATION IN CHINA

Fighting China is trying to drive home to its people some simple lessons. Through lantern slides, posters and slogans the government of Chiang Kai Shek seeks to educate its people to these modern commandments:

1. Change all your bad habits. Refuse graft.
2. Don't waste your time chatting.
3. Be brave. Don't run away from danger.
4. Help increase production of essential foods and goods.
5. Go to bed early. Get up early. Work energetically. Increase your efficiency.
6. Improve your daily life. Do away with all improper pleasures. Give up meaningless entertainment.
7. Love your nation and drive out the pygmy invaders who have fallen upon our land.

SCIENCE AND WAR

The modern sciences of radio and electronics have their roots in peaceful soil—in the search by men of good will for ways and means to make the world a better place to live in. Yet these sciences, and all science, are now enlisted in total war.

Total war as it is fought today is more than a war of populations, or mere quantity of weapons, or alone the human qualities of courage and endurance. More than ever before in history, this war is a contest between the brains and imagination and teamwork of the scientists, engineers, and production workers of one group of nations, pitted against those of another group. While it is true that the decision ultimately will be made on the battlefield, the high seas, and in the air, the fighting men who have the greatest resources of science, engineering and production back of them will be the victors.

COLONEL DAVID SARNOFF

CHEMISTRY FOR THE CONSUMER

II. DRUGS AND COSMETICS

WILLIAM C. CURTIS
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In a previous article the author suggested that the present offerings in general chemistry be revised or enriched so as to include those principles which are most often needed in solving the problems of the individual as a consumer. Every person is a consumer of goods and services. As one authority pointed out, the consuming of materials is the most important single voluntary activity of man.

The subject of drugs and cosmetics ranks close to the topic of food in importance and general interest. In this connection, the average citizen should be provided with an adequate basis for selecting such products on their merit rather than the misrepresentations or false or misleading claims under which they are frequently advertised. High-school chemistry courses can be modified so as to provide such training by the inclusion of subject matter dealing with the composition, cost of production, quality, and utility of these products and the relation of these to price.

A brief summary of those facts and principles relating to drugs and cosmetics which are of use and interest to adults is given below. This material need not be substituted for any of the regular course work. It may be done as supplementary reading and experimental work followed by written reports.

DRUGS AND THEIR SCIENTIFIC USE

1. Drugs are all medicines intended for internal or external use in the "diagnosis, cure, mitigation, treatment, or prevention of disease of man or other animals; and articles (other than food) intended to affect the structure and function of the body of man or other animals."
   The *U. S. Pharmacopoeia, National Formulary*, and their supplements are the legal standards for drugs in the United States. These works describe most of the medicines of known therapeutic value. The term "U.S.P." or "N.F." on a label means that the product conforms with the quality or strength or composition laid down in these standard references.
2. It is impossible for any medicine of a definite formula to

cure all diseases. A specific disease requires a specific remedy. A given medicine may be beneficial in some cases and useless, or even harmful, in others. Only a few of the medicines known to medical science actually cure the diseases by eradicating the cause. Most medicines of known therapeutic value act on the body in a general way. The therapeutic effects they produce are not always understood and may vary with different individuals.

Self-Medication

1. The scientific treatment of disease requires a careful diagnosis and regulation of the dosage of prescribed medicines or manner of treatment as the patient's condition improves or grows worse. The average individual is incapable of self-diagnosis or properly prescribing for himself in the case of illness. Then too, the self-treatment of disease frequently results in a postponement of proper treatment which may seriously impair the chances of recovery.
2. The safest procedure is to follow the advice of a reputable physician in the selection and use of drugs. Self-medication should be limited to the use of drugs for simple ailments and as first aids. Appropriate home remedies "should contain no habit forming or dangerous drugs; they should not be recommended for diseases that are too serious for self-treatment; they should be non-secret because the public has a right to know what it is taking; finally, they should not be advertised under false claims or in such a way as to make the public magnify trivial ailments or dose itself unnecessarily with drugs."

Patent Medicines

1. Most of the remedies which are colloquially called "patent medicines" are not patentable but "simple mixtures of well known drugs, drugs that are—or have been—in daily use by physicians." It would be more appropriate to term such products proprietary medicines.

Analgesics

1. Analgesics are the most widely consumed proprietary medicines. The use of analgesics to relieve pain does not correct the underlying cause which may be of a serious organic nature. Aspirin is probably the safest analgesic for general

use. Its promiscuous use, however, may result in a rather severe poisoning. Since aspirin is a distinct chemical compound, acetylsalicylic acid, it is the same regardless of who makes it. Analgesics containing acetanilid, antipyrin, phenacetin, or amidopyrin should not be used except on a physician's prescription. These substances are dangerous drugs.

Cosmetics

1. A cosmetic may be defined as "anything intended for cleaning, altering the appearance of, or promoting the attractiveness of a person." The action of a true cosmetic is temporary and corrective rather than permanent or therapeutic. Cosmetics intended to possess therapeutic value or affect the structure or function of the body should be regarded as drugs.
2. Cosmetics should be made of pure materials (e.g., U.S.P. grade or equivalent) and manufactured under carefully controlled conditions. Moreover, they should not contain coarse, irritating, or harmful ingredients, or substances which are prone to rancidity or impart offensive odors.

Cosmetics in Relation to the Care of the Mouth

1. The method and thoroughness of brushing is more essential to the care of the teeth than the type of dentrifrice used. The function of a dentifrice is to serve as a slight mechanical aid to the tooth brush in cleaning the accessible surfaces of the teeth.
2. Dentifrices designed for daily use should not contain pumice, silicates, phosphates, or other harsh abrasives which may scratch the enamel or expose the cementum. Furthermore, such dentifrices should not contain sodium perborate, sugar, potassium, chlorate, borax, betanaphthol, orris root, fluorides, acids, or alkalies. Many modern dentifrices contain sulfated detergents (soap substitutes) advertised under such trade names as "Irium," "Lusterfoam," etc. There is no evidence, however, to indicate that such substances are of any particular value as dentifrices.
3. Other things being equal, tooth powders are generally cheaper than pastes, and there is no significant difference in their cleansing properties under the usual and ordinary conditions of their use. The exact usefulness of liquid

dentifrices has not yet been determined. They may be highly satisfactory cleaning agents in many cases. In others, however, the abrasive action of tooth powders and pastes may contribute to a greater degree of cleanliness. Liquid dentifrices are usually alcoholic solutions of a cleansing agent (soap, soap bark, or a soap substitute), an antiseptic (boric acid, hydrogen peroxide, etc.), glycerin, and coloring and flavoring materials.

4. Under the conditions of their use, mouth washes have no therapeutic or antiseptic value, and are incapable of neutralizing mouth acidity. At best they may be "somewhat useful in that the vigorous use of them after brushing the teeth rinses from the mouth any food particles loosened by brushing." Mouth washes intended for daily use should not contain phenol, sodium perborate, or other harmful ingredients.

Function of Cosmetics with Reference to the Skin

1. The skin must be nourished by the assimilation of digested foods from the blood stream. All preparations applied to the unbroken skin act only on the epidermis, and have no direct effect on the dermis. Surface acting cosmetics "can serve only to keep the horny layers clean, soft, and more pliable," and help to keep the skin active by encouraging massage. The most essential factors to the maintenance of a healthy skin are suitable exercise, proper rest and diet, and regular elimination.
2. A dry skin usually rebels against cold weather and excessive washing with soap and water. Since such a skin does not attract and retain dirt, it does not require frequent bathing. The undesirable effects of a deficiency of natural oils may be partially offset through the use of appropriate greasy ointments. Oily skins should be washed frequently with soap and water. Excessive oiliness is best relieved through the use of suitable astringents.

Skin Creams

1. Creams are probably the most useful of the cosmetics designed for use on the skin. The most popular skin creams are cold creams, quick liquefying creams, foundation creams, and astringent creams. These preparations are either emulsions or non-emulsions.
2. Cold creams are essentially emulsions of oils with waxes or

other emulsifying agents and water. In the preparation of these products, mineral oils and lanolin are commonly employed as the oil bases,

3. Waxes are esters of fatty acids and monohydric alcohols such as cetyl alcohol. They resemble fats in outward appearance, and are insoluble in fat solvents. Some waxes may be saponified, yielding a fat alcohol in place of glycerol. The solid waxes possess the property of forming emulsions with water. They are such good emulsifying agents that "large quantities of water can be incorporated with them and with the production of slave-like substances." Spermaceti and beeswax are the most widely used natural waxes. New synthetic waxes, however, are rapidly replacing these waxes in modern cold creams. Then too, various soaps, gums, such as acacia and tragacanth, etc., are sometimes used in place of waxes as emulsifying agents.
4. Lanolin or wool fat is an ester of cholesterol, a high molecular weight alcohol, and a fatty acid. It does not get rancid, and is similar in composition to the natural oils of the skin. It usually imparts a distinctly yellow or creamy color and a sticky feeling to creams. Due to the ease with which it is absorbed by the skin, it must be "blended with other fats and waxes to insure free lubrication during massage." Cholesterol is frequently used with other fats to avoid the stickiness of lanolin and yet preserve most of its advantages.
5. Many skin creams now on the market contain vitamins, hormones, and other special ingredients which, when incorporated in proper bases, can be absorbed through the skin. The therapeutic action of these substances on the skin has not yet been determined. It appears, however, that any benefits to be derived from their presence in creams is due to their action on the body as a whole and not to their action on the skin alone. These substances are unstable and decompose readily. Hence, all preparations containing such ingredients should be manufactured under carefully controlled conditions in order to prevent deterioration.
6. Cold creams are most suitable for use on dry skins. They serve as an aid to soap and water in cleansing the skin, encourage massage, help to offset the effect of a lack of natural oils, and may afford some measure of protection against conditions which have a drying and wrinkling effect on the skin.

7. The so-called "quick liquefying" creams are non-emulsion creams composed chiefly of mineral oils and waxes. These preparations are translucent, spread easily, and have low melting points. They are very efficient cleansing creams, and are best used on oily skins because of their drying action.
8. Most foundation creams have a vanishing cream base consisting chiefly of an emulsion of stearic acid and water. Such preparations deposit a thin film on the skin. Foundation creams with an ointment base are rapidly increasing in popularity. Products of this type are usually tinted to blend with the complexion, and give the skin a fresh appearance.
9. Astringent creams usually contain zinc compounds, alum, or other substances having astringent action on the skin. They are designed primarily for oily skins.
10. Because such substances as phenol, lard, spermaceti, certain perfume materials, such as oil of bitter almonds, etc., are known to cause allergy, their presence in skin creams and other cosmetics is generally considered objectionable.

Powders

1. Face powder is one of the most widely consumed cosmetics. The main purpose of a face powder is to improve the appearance of the skin by toning down the gloss or shine and minimizing minor skin defects. A good powder is characterized by fineness and softness of its ingredients and freedom from substances known to cause allergies. Rice starch is about the only harmful ingredient likely to be found in face powders. A few, however, may contain orris root. Some persons are allergic to even minute amounts of these substances. When used on some skins, starch may cause dryness or irritation.
2. Face powders are generally classified as light, medium, or heavy weight. In this connection, weight refers to covering powder and not to the specific gravity of the powder. The weight or clinginess of a powder depends upon the balance between zinc oxide or titanium dioxide and zinc stearate or other substances which give it adherence and slip. Dry skins usually require a light powder, oily skins, a heavy one.
3. Powders for dusting infants and children are usually a combination of zinc stearate and stearic acid. These powders

should be unscented and uncolored. Zinc stearate has been found to be poisonous, especially when inhaled by children. Children, therefore, should never be dusted profusely with powder to permit its being taken into the body.

4. Rouge is modified face powder containing added coloring matter and binders. Cake rouge contains coloring matter dispersed in waxes and oils. It is basically the same as powder rouge but is more economical.

Freckle Removers, Skin Peelers, Etc.

1. Cosmetics designed to change the color of the skin must be inherently dangerous in order to be truly effective. For this reason, freckle removers, skin peelers, bleaches, and whiteners should not be used on the skin. These products are likely to contain such definitely harmful substances as mercuric chloride, ammoniated mercury, magnesium sulphate, carbolic acid, various arsenic compounds, or salicylic acid.

Deoderants

1. Unpleasant perspiration odors are likely to occur where light and air do not penetrate. Such odors are due to bacterial fermentation, and may be offset through the use of appropriate deodorants. Deodorants fall into two general groups, antiperspirants and antiseptics.
2. Anti-perspirants contain as active ingredients such astringents as tannic acid, ammonium alum, and aluminum salts (sulphate, chloride, acetate, etc.). They act by suppressing perspiration in the small areas to which they are applied, thereby diverting it to some other part of the skin from which it can evaporate more readily. Deodorants of this type are likely to contain ingredients that irritate the skin or injure fabrics. When aluminum salts are used as the active ingredients, their concentration should not exceed 25%.
3. Antiseptic deodorants are intended to remove any surface bacteria likely to bring about the decomposition of perspiration. Deodorants of this type are generally harmless. They are usually composed of boric acid, benzoic acid, or zinc stearate combined with talc or pleasant smelling antiseptic ingredients such as chloramine.

Cuticle Removers

1. Cuticle removers are aqueous-glycerin solutions of sodium

or potassium hydroxide. They are usually perfumed and colored. Such products should not contain over two per cent of free alkali. Too much free alkali may permanently damage the fingernails. When these products are used, they should be removed promptly and olive oil applied to the treated areas.

Cosmetics in Relation to the Hair

1. The hair is similar in composition to the horny layer of the epidermis of the skin. It grows from the so-called root hair or bulb at the bottom of the follicle. The hair bulb is fastened over tiny organs called papilla. Like the epidermis, it has no blood vessels of its own, but derives its nourishment from the blood vessels of the papilla.
2. As in the case of any other tissue, the hair cannot be nourished by external applications. One of the chief factors in maintaining a healthy growth of hair is cleanliness of the scalp. The growth of the hair is usually stimulated by proper massage. "Massage, as commonly practiced, is liable to do more harm than good. The principal object of manipulation should be to secure a good flow of arterial blood to the part and not to spread bacteria, whose normal habitat is in the outer layers of the scalp, by rubbing the surface of the skin."
3. The form of the hair, that is whether it is straight or curly, is determined by the shape and curvature of the hair follicles. The color of the hair depends upon the quantity and density of pigment in the middle portion of the hair. Grey hair results from a loss of pigment.
4. In connection with cosmetics designed for use on the hair, it is well to remember that no known substance will stimulate the growth of hair, restore grey hair to its original color, safely or permanently prevent the growth of hair, or permanently change the form of the hair.
5. Dandruff, one of the most widespread disorders involving the scalp, is usually a part seborrheic dermatitis, and concomitant with baldness.

Hair Oils

1. Suitable oils may be used to lubricate the scalp when there is a deficiency of natural oils. These oils help to prevent the scalp from becoming dry and the hair brittle and lusterless.

Hair oils should be of medium viscosity, free from stickiness, and should not turn rancid on the hair. "Preparations containing animal fats (lanolin, neatsfoot oil) give the best effect; vegetable oils (castor, olive) come next; while mineral oils are not only the least beneficial but are definitely drying after continued use. On the other hand, for glossiness the order is reversed." The presence of suitable anti-oxidants will prevent the vegetable oils from turning rancid.

Hair Tonics and Dandruff Remedies

1. Hair tonics are usually mixtures or dilute alcohol solutions or a combination of some of the following ingredients: quinine, sulphur, glycerin, resorcinol, arsenic compounds, salicylic acid, cantharides, pilocarpin, etc. The presence of arsenic compounds, salicylic acid, resorcinol, and cantharides in hair tonics is objectionable because they sometimes cause serious skin poisonings. Quinine sometimes causes allergy.

Hair Dyes

1. Hair dyes fall into three groups: natural vegetable dyes, metallic dyes, and coal tar dyes. These substances do not produce permanent results, and all of them are potentially dangerous. Coal tar dyes are probably the least harmful of the hair dyes. Even these, however, are capable of causing acute skin irritation.

Depilatories

1. Depilatories are intended to remove superfluous hair. Most depilatories contain alkaline earth sulphides, in alkaline media as their active ingredients. Perfume materials are generally added to such products to cover the odor or hydrogen sulphide. The alkaline earth sulphides are hair solvents. They frequently cause skin irritations. Depilatories containing thallium acetate should never be used by the public. This substance is extremely poisonous.

SUGGESTED ACTIVITIES

Demonstration Experiments

1. The use of a laboratory homogenizer.
2. Detection of acetanilid in headache remedies, cold and grippe powders, etc.
3. Detection of phenolphthalein in laxative gums and candies.
4. Preparation of items commonly found in home medicine cabinets.

Student Experiments

1. Qualitative analysis and preparation of dentrifrices.
2. Preparation of skin creams and lotions.
3. Detection of starch and orris root in face powders.
4. Preparation of face, talcum, and infant dusting powders.
5. Preparation of rouge.
6. Detection of mercury in bleach creams and freckle removers.
7. Preparation of bath salts.
8. Preparation of deodorants.
9. Detection of astringents in deodorants.
10. Determination of free alkali in cuticle removers.
11. Preparation of cuticle removers.
12. Preparation of hair oils.
13. Detection of arsenic compounds in hair preparations.
14. Detection of lead, copper, silver, iron, and coal tar dyes in hair dyes.
15. Preparation of finger-nail enamel and polish remover.
16. Detection of sulphides and thallium salts in depilatories.

Written Exercises

1. Prepare a chart explaining the use and chemical behavior of antidotes for arresting the action of

Strong acids	Phosphorus	Iodine
Caustic alkalies	Silver nitrate	Carbolic acid
Ammonia	Mercury compounds	Benzene
Arsenic and its Salts	Lead compounds	Strychnine

2. Complete the following chart and include all items which you think a home medicine cabinet should contain

Item	Purpose
Absorbent cotton, U.S.P.	Dressing
Tincture of Iodine, U.S.P. or other suitable antiseptics	Tissue surface disinfection

Projects

1. Methods of Administering Drugs—the avenues by and through which medicines enter the system (skin—hypodermic and epidermic, lungs, arteries, veins, rectum, etc.).
2. Chemical Tests to Aid Diagnosis—the importance, methods of administering, and limitations of the most widely used clinical tests.
3. Chemistry in the Treatment of Disease—the importance of anesthetics, antiseptics, x-rays, serum therapy, chemotherapy, glandular therapy, electro-therapy, specific, and synthetic products.
4. Patent Medicines—analysis, evaluation, and duplication of a number of widely used proprietary medicines.
5. Cosmetics—a study of the composition and manufacture of cosmetics, with conclusions as to the relation between the cost of their production and selling price and their effect upon the skin.

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PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

A LATE SOLUTION

1759. *Proposed by John P. Hoyt, Annapolis, Md.*

If quadrilateral $ABCD$ be inscribed in a circle with AB and DC meeting at E; AD and BC meeting at F; with EH and FK as tangents, prove that $EF^2=EH^2+FK^2$.

First solution by Milton E. MacGregor, Needham, Mass.

$ABCD-E, F$ is a complete quadrilateral. Draw its diagonals AC, BD and EF and let them intersect in points W, L and M.

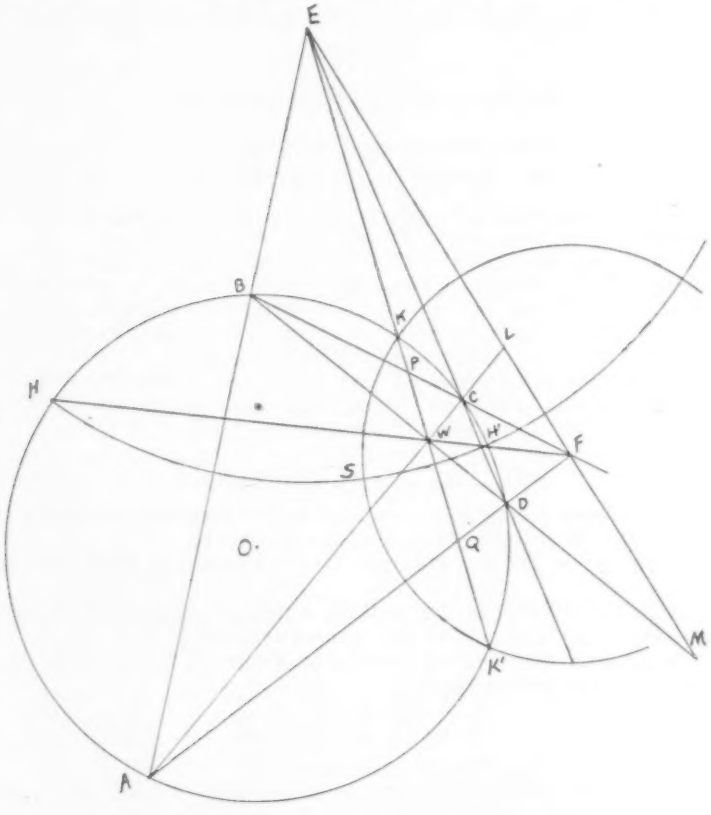
(AC, WL) is harmonic, also (BD, WM) is harmonic.

$\therefore MFLE$ is the polar of point W.

Draw EW and let it intersect BC in P, AD in Q and the circle O in K and K'. Then $E(AC, WL)$ is harmonic.

$\therefore (FQ, DA)$ and (FP, CB) are harmonic. Also PQ or KK' is the polar of F so that tangents from F to circle O meet the circle K and K'. In the same manner tangents from E will meet the circle at H and H' where FW cuts the circle.

Draw circles with E as center, EH as radius and with F as center and FK as radius. Since (EW, KK') is harmonic and KK' passes thru the center E then KK' are inverse points for circle E.
$\therefore$ Circles E and F are orthagonal as circle F passes thru two points inverse for circle E.
$\therefore$ Radii of the circles to their point of intersections will be perpendicular. Then $ES^2+SF^2=EF^2$ or substituting equal radii, $EH^2+FK^2=EF^2$.



Second solution by Walter R. Warne, Rochester, N. Y.

From Exercise 2 page 114, Court's *College Geometry* we have, using the given figure:

$$EF^2=OE^2+OF^2-2R^2.$$

This can be written in the form: $EF^2=(OE^2-R^2)+(OF^2-R^2)$. Now from the right triangle relation established in first solution it follows that:

$$EF^2=EH^2+FK^2$$

1771. *Proposed by Claude P. Rook, Chillicothe, Ohio.*
Resolve into two factors $2x^4-5x^3-x^2-2$.

Solution by Roy C. Warne, Tecumseh, Michigan

Assume:

$$2x^4-5x^3-x^2-2=(x^2+px-2)(2x^2+qx+1).$$

Expanding and equating coefficients of like terms and solving it is found that $p=-2$ and $q=-1$. Hence the factors are:

$$(x^2-2x-2)(2x^2-x+1).$$

Solutions were also offered by Walter R. Warne, Rochester, N. Y.; Zada Serven, Tyre, N. Y.; Norman Anning, Ann Arbor, Mich.; and Jean Andres Thomas, Little Falls, N. Y.

1772. *Proposed by J. Seward Bodine, Salt Lake City, Utah.*

If n is any positive integer, show that

$$\frac{1}{\sqrt{2n+1}}>\frac{1\cdot3\cdot5\cdots(2n-1)}{2\cdot4\cdot6\cdots2n}>\frac{\sqrt{n+1}}{2n+1}.$$

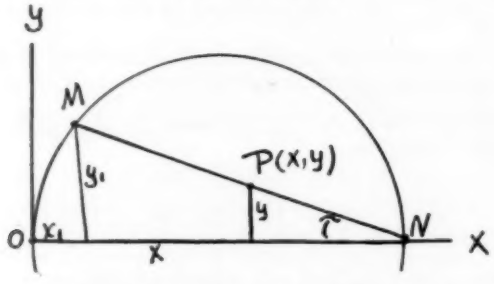
Solution by Richard Kadison, New York City

The solution is by mathematical induction. First, the left hand inequality is established by testing its validity for $n=1$, 2. Then the test is made for $n=m+1$ and the proof is established. The remaining inequality or the right hand one is treated in like manner.

EDITOR'S NOTE: Mr. Kadison gave all details of the proof. This problem is solved in Barnard and Child's *Higher Algebra*.

1773. *Proposed by Hugo Brandt, Chicago, Ill.*

A variable chord MN making an angle of $\tau=$arc tangent t with the diameter ON of a circle with radius r is divided by point P so that $MP:PN=(1+2t-t^2):(1+t^2)$; find the locus of point P.



Solution by Hugo Brandt, Chicago, Ill.

In an ordinary coordinate system with origin O lay the diameter ON along the positive x-axis. The circle, then, has the equation:

$$y^2+(x-r)^2=r^2. \tag{1}$$

$\therefore x^2+y^2=2xr$. For the point $M(x_1, y_1)$ we have

$$\text{tangent } \tau=t=\frac{x_1}{y_1}; \tag{2}$$

$$x_1=ty_1.$$

Since $x_1^2+y_1^2=2x_1r$, we have $(tx_1)^2+(ty_1)^2=2x_1rt^2$
$\therefore (tx_1)^2+x_1^2=2x_1rt^2$ and hence:

$$x_1=\frac{2rt^2}{1+t^2}. \qquad y_1=\frac{2rt}{1+t^2}. \tag{3}$$

If the variable ratio is called n, that is:

$$\frac{1+2t-t^2}{1+t^2}=n,$$

a consideration of the coordinates of $P(x, y)$ and of $M(x_1, y_1)$ leads after some algebraic manipulation to:

$$\frac{y_1-y}{y}=n; \qquad \frac{x-x_1}{2r-x}=n, \quad \text{since} \quad \frac{MP}{PN}=n.$$

$$\therefore \quad y=\frac{y_1}{n+1}; \qquad 2r-x=\frac{2r-x_1}{n+1}. \tag{4}$$

Inserting above values of x_1, y_1 and n_1 in (4)

$$y=\frac{2rt}{2(1+t)}=\frac{rt}{1+t}.$$

Hence

$$t=\frac{y}{r-y}.$$

Also

$$2r-x=\frac{2r}{2(1+t)}=\frac{r}{1+t} \quad \text{and} \quad t=\frac{x-r}{2r-x}.$$

By equating values for t,

$$\frac{y}{r-y}=\frac{x-r}{2r-x} \quad \text{or} \quad y(2r-x)=(r-y)(x-r) \quad \text{or} \quad y=x-r,$$

representing a line under 45° against the positive x-axis, passing through the center of the circle, is the required locus.

1774. *Proposed by Norman Anning, University of Michigan.*

(1) Show that equations:

$$\begin{aligned} 67a &= 49x+18y+42z \\ 67b &= 18x+49y-42z \\ 67c &= -42x+42y+31z \end{aligned}$$

imply $67x=49a+18b-42c$ and two similar expressions.

(2) Find coefficients for a corresponding problem in which 67 is replaced by 11.

Solution by Jean Andres Thomas, Sherburne, N. Y.

(1) Let D be the determinant of the coefficients of x, y, and z.

$$D=\begin{vmatrix} 7^2 & 67-7^2 & 6.7 \\ 67-7^2 & 7^2 & -6.7 \\ -6.7 & 6.7 & 67-6^2 \end{vmatrix}.$$

If D' is the adjoint of D, then

$$D'=\begin{vmatrix} 67.7^2 & 67(67-7^2) & 67(6.7) \\ 67(67-7^2) & 67.7^2 & 67(-6.7) \\ 67(-6.7) & 67(6.7) & 67(67-6^2) \end{vmatrix}=67^2D.$$

But $D'=D^2$. Therefore, $D=67^3$. From the adjoint determinant we may write at once:

$$67x=49a+18b-42c$$
$$67y=18a+49b+42c$$
$$67z=42a-42b+31c.$$

(2) Substituting 11 for 67, m for 7, n for 6, let Δ be the determinant corresponding to D above.

$$\Delta=\begin{vmatrix} m^2 & 11-m^2 & mn \\ 11-m^2 & m^2 & -mn \\ -mn & mn & 11-n^2 \end{vmatrix}.$$

That Δ should have as its adjoint $11^3\Delta$, it is necessary that $\Delta=11^3$. Expanding the determinant and setting it equal to 11^3, we have:

$$2m^2+n^2=22.$$

This condition is satisfied by $n=3$, $n=2$, and by no other integral values of m and n. The new set of equations is then:

$$11a= 9x+2y+6z$$
$$11b= 2x+9y-6z$$
$$11c=-6x+6y+7z.$$

Coefficients for a corresponding problem may be found for any number p which may be written in the form

$$p=m^2+n^2/2,\ m, n \text{ both integers.}$$

For example 51 is such a p, for in this case $m=7$, $n=2$.

A solution was also offered by the proposer.

1775. *Proposed by Helen M. Scott, Baltimore, Md.*

Given a triangle with sides of 7, 8, and 9 units. A parabola, $y^2=2px$, is tangent to the "8" side and tangent to the other two sides, produced. Find the maximum value for p.

Solution by the proposer

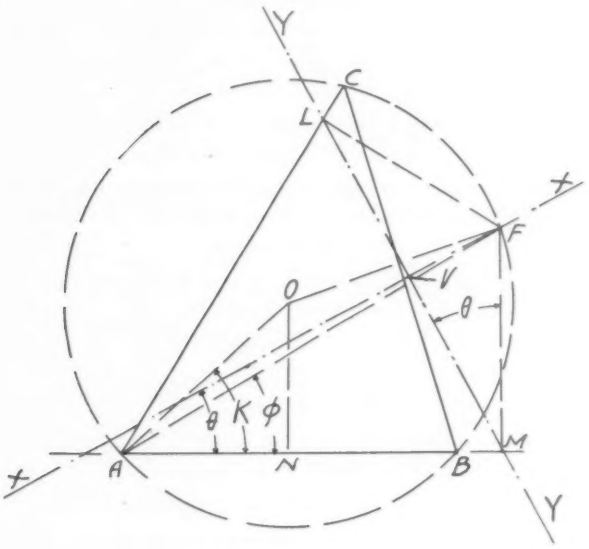
This solution depends on two properties of the parabola: the circumcircle of the triangle formed by any three tangents passes through the focus; a perpendicular from the focus to any tangent meets it on the Y-axis. It also depends on the fact that $A=\theta+\phi$.

In the diagram, $AB=7$; $BC=8$; $AC=9$; R is the radius OA; F the focus and $FV=a=p/2$.

First, the proof that $\theta=A-\phi$, will be given.

$$OA=OF=R$$
$$AF=2R\cos(K-\phi), \text{ using law of cosines} \tag{1}$$
$$AM=AF\cos\phi=2R\cos\phi\cos(K-\phi) \tag{2}$$
$$AL=AF\cos(A-\phi)=2R\cos(K-\phi)\cos(A-\phi) \tag{3}$$
$$DL=AL\sin A=2R\sin A\cos(K-\phi)\cos(A-\phi) \tag{4}$$
$$AD=AL\cos A=2R\cos(K-\phi)\cos(A-\phi)\cos A \tag{5}$$
$$DM=AM-AD \tag{6}$$
$$DM=2R\cos(K-\phi)\cos\phi-2R\cos(K-\phi)\cos A\cos(A-\phi) \tag{7}$$
$$DM=2R\cos(K-\phi)[\cos\phi-\cos A\cos(A-\phi)] \tag{8}$$
$$\tan\theta=\frac{DM}{DL}=\frac{2R\cos(K-\phi)[\cos\phi-\cos A\cos(A-\phi)]}{2R\cos(K-\phi)\sin A\cos(A-\phi)} \tag{9}$$

$$\tan\theta=\frac{\cos\phi-\cos A\cos(A-\phi)}{\sin A\cos(A-\phi)}. \tag{10}$$



Reducing the numerator:

$$\begin{aligned}\cos\phi-\cos A\cos(A-\phi)&=\cos\phi-\cos A[\cos A\cos\phi+\sin A\sin\phi] &(11)\\ &=\cos\phi-\cos^2 A\cos\phi-\cos A\sin A\sin\phi\\ &=\cos\phi-(1-\sin^2 A)\cos\phi-\cos A\sin A\sin\phi\\ &=\cos\phi-\cos\phi+\sin^2 A\cos\phi-\cos A\sin A\sin\phi\\ &=\sin A(\sin A\cos\phi-\cos A\sin\phi) &(12)\\ &=\sin A\sin(A-\phi). &(13)\end{aligned}$$

Putting (13) in (10)

$$\tan\theta=\frac{\sin A\sin(A-\phi)}{\sin A\cos(A-\phi)} \tag{14}$$

$$\tan\theta=\tan(A-\phi) \tag{15}$$

$$\theta=A-\phi$$

and $$A=\phi+\theta. \tag{16}$$

Since $\theta=A-\phi$,

$$a=2R\cos(K-\phi)\sin\phi\sin(A-\phi) \tag{1}$$

$$a=2R(\cos K\cos\phi+\sin K\sin\phi)(\sin A\cos\phi-\cos A\sin\phi)\sin\phi.$$

Let $2R\cos K=D$; $2R\sin K=E$; $\sin A=F$; $\cos A=G$. (2)

$$a=DF\cos^2\phi+(EF-DG)\sin\phi\cos\phi-EG\sin^2\phi. \tag{3}$$

Differentiating and eliminating $\cos\phi$

$$\frac{da}{d\phi}=[DF-3\ DF+EG)\sin^2\phi]\sqrt{1-\sin^2\phi}-(EF-DG)(3\sin^3\phi-2\sin\phi)=0. \tag{4}$$

Let $DF=H$; $3(DF+EG)=J$; $(EF-DG)=L$ (5)

$$(H-J\sin^2\phi)\sqrt{1-\sin^2\phi}=L(3\sin^3\phi-2\sin\phi). \quad (6)$$

Squaring and combining:

$$(9L^2+J^2)\sin^6\phi-(12L^2+2JH+J^2)\sin^4\phi+(4L^2+2JH+H^2)\sin^2\phi-H^2=0. \quad (7)$$

Substituting the given values, (7) becomes

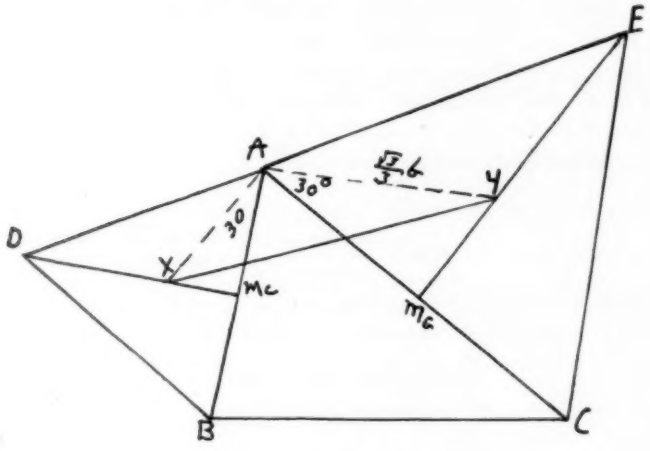
$$793.776\sin^6\phi-1132.773\sin^4\phi+377.323\sin^2\phi-35.551=0 \quad (8)$$

one root of (8) is 0.5084153 and $\phi=30°33'30''$. (9)

In (1) this gives $a=2.187957$ and $p=4.375914$. (10)

1776. *Proposed by Wilson Thorton.*

On the sides of any triangle ABC, there is constructed equilateral triangles ADB, AEC, and CFB. If X, Y, and Z are the points of concurrence of the medians of these triangles, show that triangle XYZ is equilateral.



Solution by Malcolm Kirk, Weschester, Pa.

From the diagram, using the law of cosines, (1) $XY^2=b^2/3+c^2/3-2bc/3\cos(60+A)$ and similar values for YZ^2 and XZ^2.

From triangle ABC, using law of cosines, $\cos A=(b^2+c^2-a^2)/2bc$ also $\sin A=\sqrt{K}/2bc$, where $K=(a+b+c)(a+b-c)(a-b+c)(b+c-a)$. Expanding, $\cos(60+A)$, and substituting values of $\cos 60°$, $\sin 60°$, $\cos A$, and $\sin A$, in (1), one obtains: $XY^2=a^2/6+b^2/6+c^2/6+\sqrt{3}/6\sqrt{K}$. From symmetry the values of YZ^2 and XZ^2 are easily found and it follows that $XY=XZ=YZ$.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

EDITOR'S NOTE TO HIGH SCHOOL STUDENTS:—It is the hope of the editor that this year will bring more contributors to this department. Please send problems, solutions, comments.

PROBLEMS FOR SOLUTION

1789. *Proposed by Cecil B. Read, University of Wichita, Wichita, Kan.*
What restriction is placed on the shape of a triangle if the sum of the tangents of the three angles is $\sqrt{3}$?

1790. *Proposed by Helen M. Scott, Baltimore, Md.*
A cardiod

$$r=20(1+\cos\theta) \quad \text{and a parabola} \quad r=\frac{10}{1-\cos\theta},$$

having the same origin, revolve about the initial line. Find the common volume generated.

1791. *Proposed by Walter R. Warne, Rochester, N. Y.*

Prove

$$\frac{1-\cos x+\cos y-\cos(x+y)}{1+\cos x-\cos y-\cos(x+y)}=\frac{\tan x/2}{\tan y/2}.$$

1792. *Proposed by Myrtis Hyatt, Newburg, N. Y.*
If b is a mean proportional between a and c, show that $(a+b+c)(a-b+c)=a^2+b^2+c^2$.

1793. *Proposed by Emily Countryman, Hastings, Minn.*

Prove

$$L_{x\to 0}\frac{e^{-a\sin x}-e^{-a\sin x}+2\tan x}{\tan x-x}=-2.$$

1794. *Proposed by Grace Taylor, Bena, Minn.*
If in a triangle $\cos B\cos C=\cos A$, prove that $\cot B\cdot\cot C=\frac{1}{2}$.

SCIENCE QUESTIONS

November, 1942

Conducted by Franklin T. Jones, 10109 Wilbur Ave., SE, Cleveland, Ohio

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HEADLINES FOR 1942–43

Keep up with SCIENCE and Industry
Streamlined Courses for 1942–43
Science and Mathematics Teaching in Wartime
Teaching Safety from Fires, Injury by Accident, Bombs
Conservation through Care of Present Equipment
Looking toward Post-war Conservation
Intelligent Reading of the News
Proper Foods and How to Help Produce Them
Life-Saving Methods—First Aid—Artificial Respiration
How to Stop Bleeding—How to Care for Those Poisoned
How to Minimize the Effects of Shock
GO SLOW—Make the injured comfortable—Keep them Alive

These matters are now vital in all school programs.

WARTIME ACTIVITIES OF GQRA MEMBERS

GQRA, No. 262, Philip B. Sharpe, formerly Greenwich, N.Y. Now at a Ship Building Plant in Maine.

"Working on the nervous system of (————) now, and my mind is not running on Science Questions although I suppose there are many non-secret ones here.

"Glad to hear from you again." PBS.

(The List on Keeping up with Industry both new names and new material has to be omitted this month.)

GQRA Members are asked to mail their photographs or any sort of pictures to the Editor of SCIENCE QUESTIONS DEPT.

A "Contributors' Scrap Book" is contemplated. I already have pictures of GQRA, No. 1, John C. Packard, and No. 430, Arthur O. Baker, FTJ

Please contribute Answers, Questions, and Problems.

JOIN THE GQRA!

ELECTROCHEMISTRY AND THE GLOBAL WAR

980. *Suggested by a chapter in "The Drama of Chemistry" by Sidney J. French, Ph.D., Professor of Chemistry, Colgate University.*

(a) Just where do the following names fit into the story of electrochemistry—Ostwald, Berzelius, Alcoa, Faraday, Davy, Hooker, Hall, Mag-cell, Arrhenius, Dow, Volta?

(b) Who was the first electrochemist? What did he electroyze? What source of electricity did he use? When did this happen?

(c) What *two* great outstanding metallurgical applications of electrolysis contribute to the war effort?

FERDINAND, THE BULL

981. *Proposed by Pat Porter (GQRA, No. 366), 214 Owen Drive, Madison, Wis.*

"Does a bull see red or does he see all the colors, red being the only one that irritates him?"

"I expect it might better be put this way: What colors does a bull see, if any?"

"Would it be possible for you to enlighten me on this subject?'

(Miss Patricia Porter is a "freshman in high school this year.")

A PEACE-TIME PROBLEM

982. *Proposed by W. R. Smith, GQRA, No. 176, Sutton's Bay, Mich.*

"Here is something that occurred to me the other day and it may interest your clientele. (If they can think of anything besides the war.)

"I have an ordinary automatic water supply system with pressure tank. The automatic switch is set to start the pump motor when the pressure falls to 20 lbs. and stop it when the pressure reaches 40 lbs.

"What would be the optimum amount of air to have in the tank when the system is put into operation? That is—the amount which would cause the pump to operate least frequently and give the largest supply of water between pumpings."

(Qy, is the answer somewhere in the neighborhood of 20 lbs.?)

"ENRICHED" FLOUR AND BREAD

20 Questions and ANSWERS are to be found in "Consumers' Guide," February, 1941, pp. 3–4.—A Publication of the Department of Agriculture, Washington, D. C.

A few only of these questions are given below. It is advised that the entire article be read.

979. (a)—What are "enriched" flour and bread?

Answer—Enriched bread is made from enriched flour. According to the recommendations of the Committee on Foods of the National Research Council, "enriched flour is white or nearly white flour which has in it specified amounts of at least two vitamins, thiamin (B_1) and nicotinic acid, and one mineral, iron." Enriched flour may also contain certain amounts of two other vitamins, riboflavin and Vitamin D, and two minerals, calcium and phosphorus, but these are not required.

Enriched flour is made by the special milling of wheat which saves the recommended amounts of the vitamin and minerals, and/or by adding to plain white flour the recommended amounts of vitamins and minerals. Due to the necessity of restoring, at least in part, older methods of milling, the kind that is made by special milling may not be on the market as soon as that made by the addition of vitamins and minerals.

(b)—Has enriched bread more food energy than plain white bread?

Answer—No. The vitamin and mineral additions do not change the energy value of bread.

(c)—Are "enriched flour and bread" foods or medicines?

Answer—They are foods, not medicines. No curative claims should be used for these products.

(d)—What other foods are valuable sources of thiamin?

Answer—Whole wheat flour; oatmeal and other whole grain cereals; beans and peas; nuts; lean pork products.

(e)—What other foods are valuable sources of nicotinic acid?

Answer—Lean meat, corned beef, chicken, liver, rabbit. Lesser amounts in milk, collards, kale, green peas, tomato juice, turnip greens.

(f)—Is nicotinic acid the same as nicotine?

Answer—No. Nicotinic acid is a vitamin found naturally in wheat and other foods. It has none of the qualities of nicotine found in tobacco.

(g)—What other foods are valuable sources of iron?

Answer—Whole wheat flour, rye flour, brown rice, oatmeal, eggs, lean meat, liver, kale, spinach and other greens, beans and peas, dried fruits, molasses.

(h) Are the synthetic (or laboratory-made) vitamins that are added to enrich bread and flour as good as the same vitamins found in nature?

Answer—They do exactly the same job in the diet although they may come from a different source.

Suggestion—Check up on radio talks about vitamins and "enriched" products and see if the claims of the advertisers are exaggerating the benefits of the products they have for sale.

ANSWERS

972. *Proposed by Harland M. Bright (GQRA, No. 428), West High School, Cleveland, Ohio, Head of Department of Science.*

Why does the efficiency of a Diesel engine tend to be greater than that of a gasoline engine?

Answer by a Diesel engineer who is a member of the GQRA.

The Diesel cycle operates at a higher efficiency than the gasoline engine cycle because of the higher compression ratio in the Diesel. The following differences give the key to the answer—

Diesel Engine	*Gasoline Engine*
	Mixture
Air and fuel oil.	Air and gasoline
	What is compressed?
Air alone.	A mixture of air and gasoline
	How exploded?
By injection of fuel.	By passing an electric spark
	Compression pressure
1020 lb. per sq. in.	500 lb. per sq. in.
	Temperature at full compression
1200 degrees F.	Must be low enough to prevent pre-ignition of mixture
	Compression ratio
16:1.	6 or 6½:1.
	Heat value of fuels
About 90,000 BTU.	About 90,000 BTU.

973. *Proposed by Harland M. Bright (GQRA, No. 428).*

How many propellers does a torpedo have and why?

Answer—Two, so that the torpedo may be made to travel in a straight line.

974. *Proposed by Harland M. Bright (GQRA, No. 428).*

What is the motive power of a torpedo?

Answer—

Maybe that depends upon whose torpedo it is. In World War I a torpedo could be followed by its "wake." The motive power was compressed air and the escaping air left a tell-tale wake of air-bubbles.

Now we are contending with a "wakeless" torpedo. Perhaps the motive power is a mixture of H and O.

In either case a motor like an air-motor is used.

965. Proposed by Ernest Lang (GQRA, No. 425), Wilson Junior College.

"I would like to know how to make up a buffer solution that has a pH of exactly 9."

Answer—Directions will be found in
Clark—*The Determination of Hydrogen Ions.*
Britton—*Hydrogen Ions.*
Kolthoff & Rosenblum—*Acid-Base Indicators.*

966. *Proposed by Harry Delfs (GQRA, No. 426), Wilson Junior College.*

"I would like to know why all the windows in the vicinity of an explosion always shatter outward and never inward."

Answer—Any explosion sets up a wave of condensations and rarefactions. The front of the wave is a condensation and presses the glass inward. The rarefaction immediately follows and draws the glass outward with double the amplitude of the initial condensation. Successive waves increase the amplitude until the glass breaks. Usually it breaks on the first rarefaction.

BOOKS AND PAMPHLETS RECEIVED

STRATEGIC MATERIALS AND NATIONAL STRENGTH, by Harry N. Holmes, *Professor of Chemistry in Oberlin College, Oberlin, Ohio.* Cloth. 106 pages. 13.5×20.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.75.

ASTRONOMY, MAPS, AND WEATHER, by C. C. Wylie, *Professor of Astronomy, State University of Iowa.* Cloth. Pages x+449. 15.5×23.5 cm. 1942. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $3.00.

A MATHEMATICS REFRESHER, by A. Hooper, M.A. American Edition. Cloth. Pages x+342. 13×19.5 cm. 1942. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $1.90.

MICROBIOLOGY AND MAN, by Jorgen Birkeland, Ph.D., *Assistant Professor of Bacteriology, Ohio State University, Columbus.* Cloth. Pages x+478. 15×23 cm. 1942. F. S. Crofts and Company, 101 Fifth Avenue, New York, N. Y. Price $4.00.

BASIC MATHEMATICS, by William Betz, *Specialist in Mathematics for the Public Schools of Rochester, New York.* Cloth. Pages x+502. 12×18.5 cm. 1942. Ginn and Company, Statler Office Building, Park Square, Boston, Mass. Price $1.48.

THE SEASHORE PARADE, by Muriel Lewin Guberlet. Cloth. 205 pages. 13.5×19 cm. 1942. The Jaques Cattell Press, Lancaster, Pa. Price $1.75.

A TREATISE ON PROJECTIVE DIFFERENTIAL GEOMETRY, by Ernest Preston Lane, *Professor of Mathematics, The University of Chicago.* Cloth. Pages ix+466. 16.5×24 cm. 1942. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill. Price $6.00.

DESCRIPTIVE GEOMETRY, by Ferdinand A. P. Fischer, M.A., and James A. Clear, M.S., *Department of Engineering, Chicago City Colleges.* Cloth. Pages vii+244. 21×27.5 cm. 1942. The Bruce Publishing Company, 540 N. Milwaukee Street, Milwaukee, Wis. Price $3.00.

RADIO IN STATE AND TERRITORIAL EDUCATIONAL DEPARTMENTS, by Carroll Atkinson, Ph.D. (*Peabody*). Cloth. 136 pages. 12.5×19.5 cm. 1942. Meador Publishing Company, 324 Newbury Street, Boston, Mass. Price $1.50.

POISSON'S EXPONENTIAL BINOMIAL LIMIT, by E. C. Molina, *Switching Theory Engineer, Bell Telephone Laboratories, Inc.* Paper. 55 pages. 19×28 cm. 1942. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.75.

A GENERAL SCIENCE WORKBOOK, by Douglass Elliott Weidner, M.S., *Teacher of Science, Southwest Junior High School, Reading, Pennsylvania.* Paper. 216 pages. 19×26 cm. 1942. The Jaques Cattell Press, Lancaster, Pa. Price $1.00.

SCIENCE OF PRE-FLIGHT AERONAUTICS FOR HIGH SCHOOLS, by the Aviation Education Research Group, Teachers College, Columbia University. Cloth. Pages xix+868. 14×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.32.

ELEMENTS OF PRE-FLIGHT AERONAUTICS FOR HIGH SCHOOLS, by the Aviation Education Research Group, Teachers College, University of Nebraska. Cloth. Pages ix+556. 14×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 96 cents.

GLOBES, MAPS, AND SKYWAYS (A Text for High School Students), Hubert A. Bauer, *Formerly Consultant G3ographer to the National Resources Planning Board. Member of Aviation Education Research Group, Teachers College, Columbia University.* Cloth. Pages viii+75. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 40 cents.

ELEMENTARY SCHOOL SCIENCE FOR THE AIR AGE (A Teachers' Guide), by Charles K. Arey, *Consultant in Science, Horace Mann Elementary School, and Member of the Aviation Education Research Group, Teachers College, Columbia University.* Cloth. Pages viii+145. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 72 cents.

THE AIR WE LIVE IN, by George T. Renner, *Professor of Geography, Teachers College, Columbia University* with the Collaboration of Hubert A. Bauer, *Formerly Consultant Geographer to the National Resources Planning Board. Members of Aviation Education Research Group, Teachers College, Columbia University.* Cloth. Pages vi+47. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 36 cents.

MATHEMATICS IN AVIATION (A Text for High School Students), by George Osteyee, *Member of Aviation Education Research Group, Teachers College, Columbia University.* Cloth. Pages vii+186. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 64 cents.

HUMAN GEOGRAPHY IN THE AIR AGE (A Text for High School Students), by George T. Renner, *Professor of Geography, Teachers College, Columbia University. Member of Aviation Education Research Group, Teachers College, Columbia University.* Cloth. Pages xiv+238. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 64 cents.

PHYSICAL SCIENCE IN THE AIR AGE (A Teachers' Guide), by J. G. Manzer, *Trenton Public Schools, Trenton, New Jersey;* M. M. Peake, *Elizabeth Public Schools, Elizabeth, New Jersey;* and J. M. Leps, *Graduate Student in Educational Administration, Teachers College, Columbia University.* Cloth. Pages ix+198. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 80 cents.

FLYING HIGH (An Anthology of Aviation Literature for Junior High School Students), by Rose N. Cohen, *Teacher of English, New York City High Schools. Member of Aviation Education Research Group, Teachers College, Columbia University.* Cloth. xiv+320. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 76 cents.

SOCIAL STUDIES FOR THE AIR AGE (A Text for High School Students), by Hall Bartlett, *Head of Social Studies Department, Garden City High School, Garden City, New York, Member of Aviation Education Research Group, Teachers College, Columbiy University.* Cloth. Pages viii+169. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 60 cents.

WINGS FOR YOU (A Book About Aviation for Senior High School Stu-

dents), by E. A. Cross, *Head of English Department, Colorado State College of Education, Greeley, Colorado. Member of Aviation Education Research Group, Teachers College, Columbia University.* Cloth. Pages ix+355. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 76 cents.

THE BIOLOGY OF FLIGHT (A Text for High School Students), by Frederick L. Fitzpatrick, *Professor of Natural Science, Teachers College, Columbia University,* and Karl A. Stiles, *Chairman, Division of Natural Sciences, Coe College. Members of Aviation Education Research Group, Teachers College, Columbia Universita.* Cloth. Pages viii+162. 13.5×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 64 cents.

GEOGRAPHIC EDUCATION FOR THE AIR AGE (A Guide for Teachers and Administrators), by George T. Renner, *Professor of Geography, Teachers College, Columbia University. Member of Aviation Education Research Group, Teachers College, Columbia University.* Paper. Pages vii+17. 14×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 20 cents.

EDUCATION FOR THE AIR AGE (A Guide for Teachers and Administrators), by N. L. Engelhardt, Jr., *Acting Director of Research, Board of Education, Newark, New Jersey. Mamber of Aviation Education Research Group, Teachers College, Columbia University.* Paper. Pages viii+55. 14×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 24 cents.

COMPARATIVE VERTEBRATE ANATOMY, by Libbie Henrietta Hyman, *American Museum of Natural History, New York City.* Cloth. Pages xx+544. 16.5×24 cm. 1942. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill. Price $3.50.

PLANE TRIGONOMETRY WITH APPLICATIONS (with tables), by William L. Hart, *Professor of Mathematics, University of Minnesota.* Cloth. Pages v 172+iii+124. 14.5×22.5 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $2.00.

A FIRST COURSE IN MATHEMATICS, by Edward Baker, *Newark College of Engineering, Newark, New Jersey.* Cloth. Pages xiii+295. 15×23 cm. 1942. +D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $3.00.

AVIATION MATHEMATICS, by A. F. Buchan, *Squadron Commander, City of Edinburgh Wing, A. T. C.;* R. Borthwick, *Squadron Commander, City of Edinburgh Wing, A. T. C.;* and William R. Wadden, *Rindge Technical School, Cambridge, Massachusetts.* Cloth. 143 pages. 13×20.5 cm. 1942. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price 88 cents.

MATHEMATICS FOR ELECTRICIANS AND RADIOMEN, by Nelson M. Cooke, *Chief Radio Electrician, United States Navy; Member, Institute of Radio Engineers.* Cloth. Pages viii+604. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y.

NUMBER RELATIONS, by F. Lynwood Wren, *Professor of the Teaching of Mathematics, George Peabody College for Teachers;* and Worth J. Osburn, *Professor of Education, University of Washington.* Grade VII. Cloth. Pages x+310. 13.5×20 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price 96 cents.

FUNCTIONAL NUMBERS, by F. Lynwood Wren, *Professor of the Teaching of Mathematics, George Peabody College for Teachers;* and Worth J. Osburn, *Professor of Education, University of Washington.* Grade VIII. Cloth. Pages x+326. 13.5×20 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.00.

YOUTH LOOKS AT SCIENCE AND WAR. A Collection of Essays by the Washington Trip Winners of the First Annual Science Talent Search Conducted by Science Clubs of America. Paper. 144 pages. 10.5×18 cm. 1942. Published Jointly by Science Service 1719 N Street, N.W., Washington, D. C. and Penguin Books, 300 Fourth Avenue, New York City. Price 25 cents.

AN OUTLINE OF PROBABILITY AND ITS USES, by Maurice C. Holmes, *Department of Physics, West Virginia University.* Paper. Pages viii+119. 13×21 cm. 1936. Burgess Publishing Company, 426 South Sixth Street, Minneapolis, Minn. Price $1.50.

EXPERIMENTS IN ORGANIC CHEMISTRY, by E. Wertheim, *Professor of Organic Chemistry in the University of Arkansas.* Cloth. Pages x+221. 15.5 ×23 cm. 1942. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $1.35.

SHOP MATHEMATICS AT WORK, by Paul L. Welton, *Head, Departments of Mathematics and Science, Jefferson High School, Rochester, New York;* and William W. Rogers, *Instructor in Related Technical Subjects, Edison Technical and Industrial High School, Rochester, New York.* Paper. Pages iv+204. 21×27 cm. 1942. Silver Burdett Company, 45 East 17th Street, New York, N. Y. Price $1.56.

BLUEPRINT READING AT WORK, by William W. Rogers, *Instructor in Related Technical Subjects, Edison Technical and Industrial High School, Rochester, New York;* and Paul L. Welton, *Head, Departments of Mathematics and Science, Jefferson High School, Rochester, New York.* Paper. Pages viii+136. 21×27 cm. 1942. Silver Burdett Company, 45 East 17th Street, New York, N. Y. Price $1.28.

HANDBOOK OF COLLEGE ENTRANCE REQUIREMENTS, by William W. Hinckley. Bulletin 1941, No. 13. 79 pages. 14.5×23.5 cm. Superintendent of Documents, Washington, D. C. Price 15 cents.

POPULAR SCIENCE BOOK LIST. Reprinted from *The Library Journal,* May 1, 1942. 8 pages. 19.5×27 cm. Library of the Woman's College of The University of North Carolina, Greensboro, N. C. Price 5 cents each and 3 cents mailing charge.

AIRPLANE MODELS AND AVIATION, by Willis C. Brown, *Supervisor of Construction of Aircraft Models, Boston Public Schools.* Paper. 43 pages. 22×30 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price 48 cents.

ELEMENTARY SCHOOL SCIENCE BULLETINS, respectively 90 and 110 Pages. 21.5×28 cm. 1941. Northport Public Schools, Northport, N. Y.

PROBLEMS IN AMERICAN LIFE: UNIT NO. 3, MAN AND HIS MACHINES, Analysis by William Fielding Ogburn, *Sewell L. Avery Distinguished Service Professor of Sociology, University of Chicago,* and Robert B. Weaver, *The Laboratory Schools, University of Chicago.* 56 pages. 15×23 cm. 1942. National Education Association, 1201 16th Street, N.W., Washington, D. C. Price 30 cents.

PROBLEMS IN AMERICAN LIFE: TEACHERS' MANUAL. Using a Resource Unit, by I. James Quillen, *Associate Professor of Education, Stanford University*. 30 pages. 15×23 cm. 1942. National Education Association, 1201 16th Street, N.W., Washington, D. C. Price 10 cents.

SOME MILITARY APPLICATIONS OF ELEMENTARY MATHEMATICS, prepared by The Department of Mathematics, The United States Military Academy, West Point, New York. 32 pages. 21×28 cm. 1942. The Institute of Military Studies, The University of Chicago, Chicago, Ill. Price 15 cents.

YOUTH CONSIDERS THE HEAVENS, by Elsa Marie Meder, Ph.D., *Research Associate, Bureau of Educational Research in Science, Teachers College, Columbia University*. Paper. Pages ix+60. 15×23 cm. 1942. King's Crown Press, 1145 Amsterdam Avenue, New York, N. Y. Price $1.00.

RED CROSS HOME NURSING, Prepared Under the Direction of Nursing Service, American Red Cross, by Lona L. Trott, R.N., B.S., *Assistant Director, Health Education, Red Cross Nursing Service*. Paper. Pages x +431. 12×19 cm. 1942. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price 60 cents.

BIBLIOGRAPHY OF SOME ACHIEVEMENTS IN CHEMISTRY 1930–1941, by Lloyd McKinley, *Professor and Head of Department of Chemistry, University of Wichita*. Paper. 61 pages. 14.5×22 cm. Bulletin No. 11. University of Wichita, Wichita, Kansas. Price 15 cents.

KEY TO THE REPTILES AND AMPHIBIANS OF ILLINOIS, by Fred R. Cagle, *Director of the Museum, Assistant Professor of Zoology, Southern Illinois Normal University*. Paper. Pages iv+35 pages. 13.5×21 cm. May be secured from College Bookstore, So. Ill. Normal University, Carbondale, Ill., or Museum of Natural and Social Sciences, Carbondale, Ill. Price 25 cents.

THE ROCKEFELLER FOUNDATION ANNUAL REPORT 1941. Paper. Pages xi+425. 14.5×22 cm. The Rockefeller Foundation, 49 West 49th Street, New York, N. Y.

GENERAL EDUCATION BOARD, founded by John D. Rockefeller in 1902. Annual Report 1941. Paper. Pages ix+145. The Rockefeller Foundation, 49 West 49th Street, New York, N. Y.

THE LIBRARIAN AND THE TEACHER OF SCIENCE, by Caroline, *Librarian*, and Warren L. Bartlett, *Science Department, Brookline High School, Brookline, Massachusetts*. Paper. 72 pages 15×23 cm. 1942. American Library Association, 520 N. Michigan Avenue, Chicago, Ill. Price 75 cents.

BOOK REVIEWS

TO DISCOVER MATHEMATICS, by Gaylord M. Merriman, *Associate Professor of Mathematics, University of Cincinnati*. Cloth. Pages xi+435. 15.5×23 cm. 1942. John Wiley & Sons, Inc., New York, N. Y. Price $3.00.

This is one of the rapidly growing group of books suitable for use in a survey course in mathematics in college. However, its use is not restricted to such a course; it could well be added to the shelves of a public library, and would be valuable in the mathematics library of any high school.

The style of writing is definitely informal, chapter headings have been selected so as to attract attention, for example: "Eventually and Forever After," "Power—and Snowballs," "The Divine Integer." In fact, at times it would seem that the text does not live up to the standard of the chapter title.

One would not expect to obtain the technical skill often demanded of the engineering mathematics student from study of this text. On the other hand one might well obtain a far better understanding of the aims of mathematics. Because of the end in view, the order of topics often seems unusual, for example, the treatment of integral calculus before the introduction of fractional, negative, and zero exponents. An elementary discussion of groups appears very early in the text, preceding such topics as graphic representation, trigonometry, and coordinate geometry.

The appendix contains historical notes and sets of exercises. In addition to the advantage of not interrupting the continuity of reading, this would seem to offer the advantage of issuing a pamphlet of alternate exercises at a later date, without the necessity of changing texts through exhaustion of problem material.

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BASIC COLLEGE MATHEMATICS, A GENERAL INTRODUCTION, by Carl Wallace Munshower and James Fletcher Wardwell, *Colgate University*. Cloth. Pages xi+612. 16×24 cm. 1942. Henry Holt and Company, New York, N. Y. Price $3.20.

The authors state that this text is designed both for the student who will take a single survey course in mathematics and the student preparing for further work in mathematics. If used as a text in a survey course, the student will no doubt attain considerable manipulative skill in the work of the traditional courses of algebra, trigonometry, analytic geometry, and calculus, but will have little knowledge of the aims of mathematics, nor of fields which lie beyond.

The text covers more ground than many colleges will be able to include in a year course, but topics may be selected without destroying the continuity of the course. Some idea of the scope of the text may be given by mentioning topics selected at random: Newton's divided-difference formula for interpolation; elementary differential equations; spherical trigonometry; infinite series, treated by means of the calculus; polar coordinates; the exponential form of complex numbers; hyperbolic functions; solid analytic geometry; probability.

There is a reasonably adequate number of problems, with answers to odd numbered examples. Tables include powers-roots-reciprocals 1–100, common and natural logarithms of numbers (5 place), four place natural values and five place logarithmic values of trigonometric functions, exponential and hyperbolic functions.

The treatment is in general quite rigorous, for example the authors are careful in the treatment of trigonometric functions of quadrantal angles and point out that identities only hold where the functions are defined. The derivation of the formula for the sine and cosine of the sum of two angles is carefully made, avoiding a rather common error of neglecting to consider directed lines.

A few points which in the opinion of the reviewer detract from the general excellence of the book may be mentioned. The index shows no treatment of significant figures nor accuracy of computation; the treatment of the mil as a unit of angular measure is extremely brief; it is not mentioned

that the student may encounter alternative definitions for the principal value of inverse trigonometric functions; the discussion of mantissa on page 211 does not agree with the definition in italics at the top of the page (by the discussion, the common logarithm of ten has no mantissa). These are relatively trivial points, which to some other teacher may be of no importance.

CECIL B. READ

PHYSICS, by Frank L. Robeson, *Professor of Physics, Virginia Polytechnic Institute.* Cloth. Pages ix+819. 15×23.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.50.

Here is a new text which will meet the requirements of many physics teachers. The type is large, diagrams clear and well made, and the important ideas stand out clearly by use of bold faced type. Practically no small type is used anywhere in the book. Important proofs are completely developed, e. g., the index of refraction on page 247, and the law of the pendulum on page 176. Recently developed parts of the subject are discussed in their proper relations with other topics; note the electron microscope and the cyclotron. At the close of each chapter is a short list of essential problems illustrating the chief topics of the chapter. No answers are given to these problems. Dimensional units are used throughout but only to summarize results and may be omitted.

In the preface we find this: "No apology is made for the use of elementary mathematics which is now either required for entrance or taken concurrently with physics in all standard colleges. Nothing more alarming than the law of cosines is needed. In a few instances calculus is employed, but that may be omitted without loss of continuity." Does the author here mean that a physics course taken by a student majoring in food chemistry is not a "standard" course? Many liberal arts students take physics who have never had nor expect to take a course in trigonometry. Such students will find sections of this book very difficult and they will have to omit the chapter on Electromagnetism and some other sections. The author has used the names of many men not usually mentioned in a general text such as Lagrange, Lami, Jurin, Loschmidt, Berliner, Boulliau, and Raoult. In general physics the student is confronted with so many names and so many ideas that he may soon become lost, hence it seems better to omit the names of many of these research men.

This is an excellent text for engineering students and those specializing in physics, but for others assignments and use must be carefully planned.

G. W. W.

PHYSICAL DEFICIENCIES

Physical deficiencies of men drafted for military duty have been found to be so general that standards are being lowered. Educational deficiencies, to which not so much publicity has been given, are equally serious. This is not because educational preparation has deteriorated since 1917 but because the requirements of the present mechanized war are very much higher. On the average, 63 per cent of the men now being inducted into the army will be used in specialized branches of the service requiring a substantial background of education, and a considerable percentage will need mathematics through trigonometry and basic physical sciences. Neither the general education nor the special training is possessed by a sufficient fraction of men called for service to meet the requirements. The deficiencies are grave. Enough men to make a very large army have been rejected for military service solely because they were unable to understand simple written instructions.

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